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CONCERNING THE JOURNAL.

The Board of Control of the OHIO JOURNAL OF SCIENCE wishes to make the following statement so that members of the Academy may be intelligently informed as to the place of the JOURNAL in the life of the Academy.

In 1900 the Biological Club of the Ohio State University began publishing the *Ohio Naturalist.* Some years later the *Naturalist* became the official organ of the Ohio Academy of Science, and was thus sent to each member. By 1915 the Academy had widened its scope to include other branches of science than biology and geology, and in recognition of this increasing activity the name of the journal was changed to THE OHIO JOURNAL OF SCIENCE.

Since then the JOURNAL has continued as an outgrowth of the *Ohio Naturalist,* serving continuously as the official publication for the Academy, and is now in its thirty-fourth year. It has welcomed and has promptly published articles in the various sciences other than the biological sciences. It has served as a repository for a large amount of information on the natural history and geology of Ohio. Its files present a fertile field for the worker in science who must know what has been done in the past in Ohio science.

At present the Ohio Academy of Science pays approximately half of the cost of publishing the JOURNAL. The other half is paid for by the Ohio State University, supplemented by income from outside subscriptions, sale of back numbers, etc. Thus the cost of publishing the JOURNAL is more than double the price to the subscriber. More than 400 subscriptions and exchanges go outside the state of Ohio, the majority to foreign countries, so that the JOURNAL is widely distributed and internationally available.

The Ohio State University and the members of the Academy benefit from the foreign mailing list because many of them

constitute exchanges, putting expensive and valuable foreign journals on the library shelves where they are available to all members of the Academy.

Considerable prestige to the Academy results from the publication of the JOURNAL, since few other state Academies support as creditable a publication. The demand for back numbers is brisk, evidencing the desirable type of articles which it is the editorial policy to publish.

In helping to support any science journal the individual knows that only a small percentage of the papers published will be of immediate interest to him, but that without his co-operation none of the papers could reach the public. There is doubtless as much of direct interest to the majority of the Academy members in the OHIO JOURNAL OF SCIENCE as there is in any of the national society journals.

As the Academy receives prestige and a convenient outlet for publishing from the JOURNAL, so the JOURNAL derives its very life from the Academy. Without the support of the Academy the JOURNAL could not hope to exist. The mutual benefit derived by the Academy (which in the last analysis means the individual members of the Academy) on the one hand and the OHIO JOURNAL OF SCIENCE on the other hand is not something to be lightly tossed aside.

SOME NOTES ON THE PLEISTOCENE HISTORY OF THE CINCINNATI REGION.

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INTRODUCTION.

Dr. Leverett's paper, "The Pleistocene of Northern Kentucky,"[1] reports the work of a pre-Illinoian glacial advance in the region of Cincinnati. So far, it has not been correlated definitely with either of the earlier glacial stages. Dr. Leverett has outlined two small areas south and west of Covington, Kentucky, on the west Cincinnati quadrangle which are covered with a deeply weathered drift which he attributes to a pre-Illinoian glacier. He considers that enough till is present in the glacial material and that the deposits show sufficient decomposition to warrant the interpretation that an ice sheet earlier than Illinoian pushed its way over the highest hills (up to 900′+ A. T.) in that part of northern Kentucky, at least. This would be a happy circumstance in view of the presence of many large erratics scattered over parts of northern Kentucky beyond the boundary of the Illinoian ice. Dr. W. R. Jillson, who has reported many of these large boulders[2] has suggested that they were brought into Kentucky by a pre-Illinoian ice sheet, but Dr. Leverett's paper is the first to report boulder clay in Kentucky attributed to an early Pleistocene ice in that state.

It is the opinion of the writer of this paper that the glacial material described by Dr. Leverett and attributed by him to the presence of an ice sheet, is water-laid instead of ice-laid, that it was deposited by flowing water rather than by ice. It is also believed that the outwash which covers most of the high land (above 800′ A. T.) in that part of northern Kentucky which appears on the two Cincinnati quadrangles and beyond the border of the Illinoian ice is probably of the same age and origin as that found in the very restricted areas outlined by Dr. Leverett. It is thought that the material was furnished

[1]Leverett, Frank. Kentucky Geological Survey, Series VI, Vol. 31, 1929.

[2]Jillson, W. R. "Glacial Pebbles in Eastern Kentucky," Science, Vol. LX, No. 1544, 1924. "Glaciation in Eastern Kentucky," Pan. Am. Geol., Vol. XLII, 1924. "Early Glaciation in Kentucky," Vol. XLIV, pp. 17–20, 1925. Also Ky. Geol. Sur., Vol. 30, 1927.

by an ice sheet as well as by the northward-flowing rivers of Kentucky and that the record points to a period when the highest hills of that part of Kentucky were covered with water—glacial water from melting ice and river water which flowed into the region and had to flow away. The question of age seems to be a matter of some uncertainty. Certain facts make these deposits appear to be of pre-Illinoian age and other circumstances, as will be discussed later, make them seem more plausibly of Illinoian age.

In the area near Covington, there was seen by Dr. Leverett a 3–4 foot layer of boulder clay and another is reported by the present writer which was 8–10 inches thick, but which disappeared within a few feet laterally as the excavation was continued. Both were underlain and overlain by sand and gravel and surrounded on all sides at like elevation by the same sort of water-laid deposit. Neither had any important areal extent, as will be shown later. There was also noted on the surface at 900′+ A. T. a sandstone boulder, perhaps 8 inches long and 5 or 6 inches thick. The boulder clay embedded in gravel is considered insufficient to justify the interpretation that northern Kentucky was overridden by a pre-Illinoian glacier. The one boulder scarcely constitutes a difficulty.

DESCRIPTION OF MATERIALS.

The glacial material southwest of Covington, Kentucky, mapped by Dr. Leverett as drift and till of pre-Illinoian age, varies considerably from place to place within a small area. In some places it is chiefly gravel, in others sand and in some places it is largely silt-like in character.

In an exposure where the material is mostly gravel, the pebbles in the upper 20–25 feet are much decomposed, many crumbling easily, and to the same depth the deposit as a whole is of a very dark brown color streaked with black along the cracks. The upper part is quite clayey, probably due to the decomposition of feldspar rocks, and has been used for molder's sand. A few chert and quartz pebbles remain. Lower down the pebbles are more solid and range in size from tiny ones to two or three inches in diameter. Many are undoubtedly of glacial origin. Such a deposit can be seen near Amsterdam road about three-quarters of a mile northeast of Ft. Mitchell. The highest elevation is 900′ A. T. by the topographic map and the deposit seems to slope down the

hillside to an elevation of about 820′ A. T., where it overlies a fine calcareous sand carrying many cemented masses of sand in concretionary form. It was a few feet above this sand at an elevation of perhaps 840′ A. T. that the thin band of boulder clay was seen by the writer. The band of boulder clay seen by Dr. Leverett was about a quarter of a mile south of this point exposed in a street excavation in the same ridge.[3] Dr. Leverett does not recall any other place where boulder clay was seen by him. The street excavation is now somewhat slumped and shows no boulder clay.

It is hardly possible that it was the same lens of boulder clay which was seen in the two exposures, because it does not appear in a deep excavation (perhaps 25 feet vertically) between the two points. Neither band of boulder clay appears in two other exposures (30–40 feet vertically) at like elevation within a quarter of a mile to the east.

At other places at the same elevation (above 800′ A. T. and covering the highest hills which are about 900′ A. T.) the same dark brown, deeply leached deposit consists of sand, either coarse or fine and showing unmistakably horizontal bedding indicative of water as the agent of deposition. One mile southwest of Covington along the Lexington pike are two such exposures. The material is fine sand in the lower part and coarser sand and gravel toward the top. One exposure shows 32 feet of sand and gravel and is leached of its lime to a depth of 23 feet. The leached portion is very compact and very dark brown except near the surface where the color is grayish. The other exposure is deeper, perhaps 40 feet, but is otherwise identical in appearance. There is nothing in either that could be mistaken for boulder clay and they are within a quarter of a mile east of the ridge where the layers of boulder clay were seen, and at a like elevation.

In Devou Park in Covington, much of the material is very silt-like, but it contains residual pebbles of chert near the surface, and layers of gravel and sand below show it to be water-laid also. The elevation is 860′ A. T. by the topographic map and the depth of the exposure is over 40 feet by measurement. It is not fresh enough to give a chance for actual measurement of the depth of leaching. The entire depth seems to be leached, but this is probably deceptive. This exposure

[3]Report of this location is contained in a private communication from Dr. Leverett.

was referred to formerly as loess,[4] but this view must be abandoned when one considers the sand and gravel present.

It is more or less irrelevant to the subject matter of this paper, but it seems improbable to the writer that any loess exists in the vicinity of Cincinnati, either north or south of the Ohio river. All the silt-like material found on the surface of the glacial mantle seems to contain residual pebbles and to grade downward into regular glacial material where the exposure is deep enough. The pebbles in loess-like material have been referred by some writers to the work of crawfish. This seems to the writer untenable as well as unnecessary. The pebbles are so uniform and constant in their distribution, that one is lead to doubt whether crawfish are sufficiently ubiquitous to account for them. At any rate, the decomposition of both gravel and boulder clay would yield a silt-like material near the surface, besides the residual pebbles.

On the weathered surface of all this mantle southwest of Covington, whether the material is mostly fine silt or sand or gravel, there are scattered an abundance of small pebbles. So many of these are of white quartz that one is reminded of the Pennsylvania conglomerate of Kentucky. One would expect that the Kentucky rivers would bring their load into such a ponded area, and to find Kentucky rocks mingled with those from Canada in the resulting deposits. This is probably the explanation. Of course, the quarts pebbles could also have been brought by the ice from the Pennsylvanian conglomerate of Ohio.

In addition to the water-laid material described above which is to be found within the areas marked by Dr. Leverett, there is to be found on most of the upland south of Cincinnati which lies outside the Illinoian ice border deposits of sand and silt, some of it gravelly. The highest level east of the Licking in the east Cincinnati quadrangle is around Cold Springs where the land rises to 880′ A. T. by the map. In many places on all this land over 800′ in elevation there is to be found sand or sandy silt or fine gravel, all decomposed, all dark brown and all stained to considerable depth with black. This tallies precisely with the major features of the deposits described above which are to be seen west of the Licking river. No deposits have been noted east of the river which are not leached of their lime.

[4]Fenneman, N. M. "Cincinnati and Vicinity," Ohio Geol. Sur. Bulletin 19, 1916, p. 138.

However, no exposure is known to the writer where a sufficient depth is penetrated to find the unleached lower part, if it exists. Dr. Leverett infers on page 13 of his paper[5] that these sands east of the Licking are to be correlated with the Ohio River Formation of Tertiary age, but it seems to the writer that they are to be referred to the same conditions which are responsible for like material at a like elevation and with a like relation to drainage west of the Licking. These deposits, then, are also regarded as a part of the deposit due to Pleistocene flooding. Good examples for study can be found in Ft. Thomas near the intersection of Grand Avenue and Highland Avenue, along the road one mile east of Cold Springs, and near Alexandria, a few miles south of the border of the east Cincinnati quadrangle. It is shown also at many other places along the ridge roads in Campbell County.

West of the Licking river, too, and outside the areas outlined by Dr. Leverett are to be found deposits of brown sand on the high ridges. This can be seen in many places on the high land around Hebron, Kentucky, in the west Cincinnati quadrangle where wells are reported which yield soft water. Since this sand correlates in appearance and elevation with that to the east, it is probably of the same origin.

The sands and gravels here discussed occur generally on high land, usually above the 800′ contour. One exception to this rule deserves to be mentioned, where waterlaid deposits in this part of Kentucky occur at about 700′ A. T. On the little 700′ A. T. hill immediately east of Newport, Kentucky, on the east Cincinnati quadrangle is a leached deposit of fine sand resting on the bed rock. It is about ten feet thick and shows horizontal bedding.

Sand and gravel showing horizontal bedding all over the highest land surface can mean only one thing and that is flowing water at that level, not necessarily and not probably at that great an elevation above sea level. Some sort of flooded condition must have maintained from which the water had to flow away. A melting ice sheet would furnish the proper kind of temporary flood and would furnish the Canadian rocks found in the gravels, while the rivers which naturally flow northward in Kentucky would add their quota to the foreign material brought by the glacier. Of the sand, further study

[5]Leverett, Frank, *loc. cit.*

may show what part belongs to the northern and what to the southern origin.

If a flooded condition covered the 900′ contour south of Covington, it must have covered a wide area in Kentucky and one might expect to find water-laid deposits anywhere that was land surface after the flood receded and from which the material was not washed away either then or later. If the age shall prove to be pre-Illinoian, it is not known to the writer over which divide the accumulated waters discharged. A great area of north central Kentucky is now lower than 900′ A. T. If these deposits can be referred to Illinoian time, it is probable that the ponded water was poured through the col at Anderson Ferry.

One mile west of Cold Springs and three-quarters of a mile east of the valley wall of the Licking river is an exposure of boulder clay at the surface which merits attention. The elevation is 840′ A. T. by the topographic map and the depth of the exposure is about five feet, though a little less than half of this can be said to be vertical and free from slump. All that can be tested is free of lime. The material is very compact, but neither darker in color nor more decomposed in appearance than ordinary Illinoian boulder clay. The upper part is loosened by decomposition only to a depth of 12 or 18 inches, another circumstance which points toward its being of Illinonian age. There are many small pebbles, chiefly of quartzite and one quartzite was found which was about three inches across. At other places within a mile north of this point on the high level east of the Licking, glacial pebbles were found on the surface in plowed fields. Though this is beyond the border of the Illinoian ice as mapped,[6] it is believed to be of Illinoian age and to occupy a significant position relative to the sand and gravel around Cold Springs.

North of the Ohio river there is to be found some water-laid material on high land covered by till. At Kennedy Heights at an elevation of 840′ A. T. coarse water-laid sand is covered with a brown, leached boulder clay. This can be seen well at the end of the Kennedy Heights car line at Kennedy Avenue and Montgomery Road. The boulder clay there is about six feet deep, contains no lime and few pebbles. Two large quartzite boulders were found in place in an excavation about

[6]Leverett, Frank, *loc. cit.*, p. 15.

ten feet deep. It is not known how much sand there is beneath the till. The excavation showed several feet.

This sand covered with boulder clay probably represents the ice which furnished the gravel for the deposits south of the Ohio which are discussed above. Unfortunately, the depth of the boulder clay is not sufficient for definite conclusions as to its age.

DEPTH OF LEACHING IN GLACIAL MATERIALS IN RELATION TO THEIR AGE.

All glacial materials which have traveled across the state of Ohio will have become limy. When exposed to the weathering of rain water, the lime will be leached from the surface downward and the depth to which this leaching has been accomplished is the best indicator of the age, modified naturally by the kind of material. Laminated clays will be least readily penetrated, boulder clay next, and sand and gravel most readily. The depth of leaching, then, will increase in this order for any given length of time.

The great depth of leaching shown in the glacial deposits southwest of Covington in addition to the decomposition of the rocks and the very dark color is the best criterion for recognition of great age.

Wisconsin gravel at Red Bank in the eastern edge of Cincinnati shows a leaching of the lime to a depth of 55 inches and in a kame south of Hamilton, Ohio, the gravel was free of lime to a depth of 46 inches. There is very little gravel of Illinoian age exposed at the surface near Cincinnati. The outwash is in most places covered with boulder clay. However, at Mariemont and Madisonville in the abandoned trough of the Ohio east of Cincinnati are places where gravel and not boulder clay form the top of the deposit. An exposure along the road in Mariemont shows a lens of gravel at the surface with boulder clay on either side of it at the same elevation and all a part of the regular valley fill. It must represent the course of a stream on the ice. In this gravel it was found that the leaching has reached a depth of 14 feet from the surface. The color in the leached zone is dark brown streaked with black and the pebbles are decomposed quite like the deposits south of Covington. However, in the gravel and sand deposits along the Lexington pike, the leaching shows a depth of 23 feet from the surface. Since leaching must proceed more slowly with depth, this

may be a great enough difference to indicate that the age of the Kentucky deposits is pre-Illinoian.

REVIEW OF ILLINOIAN AND WISCONSIN GLACIAL HISTORY AT CINCINNATI.

Omitting for the moment consideration of the work of a pre-Illinoian glacier it may be well to review briefly the events of glacial history in northern Kentucky and southern Ohio which are more recent and therefore more clear. The water-laid deposits described above with one exception known to the writer are not lower than 800′ A. T., which seems to indicate that the drainage at that time was scarcely lower. After that, presumably, and before Illinoian time, the streams were able to entrench themselves more than 400 feet below this level. Such a deep valley now abandoned and partially filled with glacial deposits can be seen northeast of the city of Cincinnati. It is about two miles wide with a rock floor at about 370′ A. T. and with walls rising sharply to 860′ or 880′ A. T. It was carved, no doubt, by the ancestral Ohio which carried during that time the Scioto and Kanawha drainage. The basin of Cincinnati in some parts and the valley of Mill creek west of the city have a rock floor of equal elevation and must therefore belong to the same period of active stream erosion. These valleys and others were partially filled with Illinoian outwash and boulder clay. This is evident in a definite terrace level along the present Ohio river and in the above-mentioned abandoned valley which is 600′ to 660′ A. T., the higher level to the north as one would expect. It consists of outwash capped with a variable thickness of boulder clay.

Some valleys east of Cincinnati were filled in the same way to a level of 700′ to 720′ A. T., as for example the valley of the Little Miami river north of Milford, Ohio, east Cincinnati quadrangle, the valley of East Fork, east of Milford, and the valleys of Dry Run and Cluff creek south of the Little Miami and southwest of Milford. It is not known how widespread this higher terrace is nor just how it correlates with the 600′+ A. T., terrace ascribed to Illinoian age.

It has been assumed that the Illinoian ice also overrode the hilltops in the vicinity of Cincinnati and a small area in northern Kentucky, because there is everywhere more or less of glacial material on the highest levels. This is in most places a thin veneer (three or four feet thick) in which case it is entirely

leached of its lime, contains few pebbles and these of chert, quartzite and basalt, and is remarkably silt-like in character. It does not seem to be loess, however, because of the constant occurrence of pebbles. Such a veneer can be seen at many places along the ridge road from Cheviot to Cleves in the west Cincinnati quadrangle. In other places the boulder clay on high levels is thick enough to show the typical Illinoian soil profile[7] with a high content of lime at about four or five feet from the surface. This can be seen, for example, in the C. & O. railroad cut at Summit, one mile south of Westwood, in the west Cincinnati quadrangle or near Crescent Springs, Kentucky, also in the west Cincinnati quadrangle.

It seems certain that it was the Illinoian glacier which obstructed the northward course of the Ohio river at Cincinnati and caused ponded water to cut through minor divides east and west of the present city and so establish the present course of the Ohio from the mouth of the Little Miami river to the mouth of the Big Miami. Such a conclusion seems justified from two lines of evidence, though another fact is hard to explain. Dr. Leverett[8] says that the col at Manchester seems to have been cut through during a pre-Illinoian glaciation and that the great amount of water poured through the channel of the Ohio was able to cut the very deep and very wide valley northeast of the city of Cincinnati. This trenching with abrupt valley walls was accomplished before the advance of the Illinoian glacier. The great width of the valley in contrast to the narrow abandoned curves of the river which originally headed near Manchester preclude the possibility of the former having been cut by the same stream as the latter. But the great amount of ponded waters added to the water of the Kanawha and Scioto systems is another matter and of a magnitude corresponding with the width of the abandoned valley. The lapse of time between the early ice which caused the Manchester divide to be broken and the Illinoian ice which caused the augmented Ohio to abandon its northward course toward Hamilton must have been considerable and the trenching during this time seems to have amounted to 400 feet, at least, near Cincinnati.

Another line of evidence which seems to date definitely this relative order of events along the Ohio river is the occur-

[7]Leighton, M. M. Journal of Geology, Vol. XXXVIII, No. 1. 1930.
[8]Leverett, Frank, *loc. cit.*, p. 26.

rence of water-laid coal and mica in a river terrace in the abandoned valley.[9] The level correlates with the regular glacial filling of the old valley (600′ ± A. T.) and the sand in which the coal and mica occur is overlain with the usual capping of boulder clay. The coal and mica must have come from the coal fields of eastern Ohio or Kentucky and the water which brought them must have flowed through the Manchester narrows. The Illinoian ice must have advanced from the north, constituting an obstacle which the water was unable to surmount.

Certain facts are hard to fit into such a picture of past events. The Illinoian glacial fill in the abandoned curve toward Hamilton rises from about 600′ A. T. at Cincinnati to 660′ A. T. north of Glendale in the Mason, Ohio, quadrangle. At Cincinnati, this is nearly 300 feet lower than the divide at Anderson Ferry, five miles west of Cincinnati, which was broken, presumably, in order to let the ponded water escape to the west. It is difficult to think that such a valley deposit is sufficient record for a front of ice which is to be credited with changing the course of such a great stream and causing its waters to spill over a 900′ ± A. T., divide. If a real glacial dam was ever built up in this valley, what has become of it? How could the same glacier be responsible for an orderly valley deposit built of outwash covered with boulder clay, at 600′+ A. T., and for the boulder clay on the highest hills near Cincinnati (900′+ A. T.)?

As to the absence of the glacial dam, another possibility presents itself. If the stream continued northward at Hamilton, Ohio, as has been stated by Tight and Fowke and Malott, instead of southwestward, as believed by Dr. Leverett and Dr. Fenneman, the dam may be considered to lie north of Hamilton where much of the original topography is, no doubt, covered with drift.

After Illinoian time, a period of trenching followed before the advance of the Wisconsin glacier to within five miles of Cincinnati on the north. All valleys which were low enough to receive it were filled with outwash to a level of 530′–560′ A. T.

Since Wisconsin time, the drainage has been carried to a lower level than this outwash, so that both these glacial deposits are to be seen as dissected terraces in most of the big valleys around Cincinnati.

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[9]Brand, L. S. "The Occurrence of Coal and Mica in Pleistocene Deposits near Cincinnati," Ohio Journal of Science, Vol. XXXII, 1932.

South of the Ohio river at Cincinnati there are the typical Illinoian deposits in the valleys east of the mouth of the Little Miami river and on the uplands as well, both east and west of the Licking in that area over which the ice advanced. As outlined by Dr. Leverett, this border shows a deep indentation to the north at the mouth of the Licking. As far as known to the writer, there are no alluvial terraces along the Licking river which correlate with the 600′ outwash of Illinonian age north of the Ohio river. Such terraces of Wisconsin age are a distinct feature and correlate perfectly with the 530′ A. T., Wisconsin outwash level at Cincinnati. The absence of such alluviation during Illinoian time may mean that the Licking was not there then. This opinion was presented by Louis Desjardins of the University of Cincinnati in a paper given before the Kentucky Academy of Science in 1931. It has been assumed by Dr. Leverett and Dr. Fenneman, however, that the Licking flowing northward carved the pre-Illinoian valley directly west of Cincinnati which is now occupied by the Mill creek flowing southward. In that case the valley south of the Ohio river must have been cleared since that time.

AGE OF KENTUCKY DEPOSITS.

Definite conclusions concerning the age of the high-level outwash in northern Kentucky probably await further field observations. If one is inclined to consider these deposits as of pre-Illinoian age, certain facts seem to substantiate that position.

1. The Kentucky sands and gravels are leached, decomposed and discolored to a greater depth than those of known Illinoian age also exposed at the surface. The difference appears to be a matter of depth alone, however, as the discoloration, the decomposition of pebbles, and the clayey content in the upper part appear the same in both.

2. The Kentucky deposits are limited to the highest levels. If deep valleys had existed at the time of this deposition, it is difficult to see how later erosion could have been so selective as to leave the material only on the high levels. It is certain that valleys as deep as 370′ A. T. had been carved before Illinoian time, because such valleys were filled with Illinoian deposits. Such reasoning would seem to date these high-level sands and gravels as pre-Illinoian and to make them correspond in age with a topography older than the valley sides.

3. As above stated, the deposits under discussion are water-laid and higher than 800′ A. T. The Illinoian terrace is also for the most part outwash with an upper limit of 600′ ± A. T. at its southern edge. It seems inconsistent that two definite levels for water-laid material could have been developed in the same glacial period with a difference in elevation of 200′. It would be more convenient to account for such discordant levels by referring the higher to an older glaciation. And again, if the Illinoian glacier has left a clearly-marked outwash level which is nearly 300 feet lower than the old Anderson Ferry col, as before noted, it is hard to suppose that such waters could have broken the divide. However, the present valley of the Ohio at Anderson Ferry is so narrow and steep-walled that it can not be referred to any very ancient time. If the sands and gravels near Covington are to be correlated in age with the cutting of the Anderson Ferry divide, it would serve to indicate the youth of both rather than the great age of both.

However, there are four more circumstances which should be pointed out in considering the age of these Kentucky deposits. After these considerations are weighed, it seems to the writer not impossible that the high-level sands and gravels near Covington may prove to be of Illinoian age, after all.

1. The deposits are largely sand and it is believed that some of it has been carried a considerable distance by flowing water. Some of it may have flowed south only to be gathered up and carried northward again. Sand that has traveled far would be partially leached, at least, when it was deposited. This may be a factor in accounting for the greater depth of leaching in the sands and gravels in Kentucky than in like material of Illinoian age in Madisonville and Mariemont. Besides, the difference is not as great as one would expect (23 feet in the former and 14 feet in the latter), considering the great length of time which is ascribed to the interglacial period which preceded the Illinoian advance.

2. Drainage would be more perfect, the water table would sink lower, and leaching would proceed faster in gravel or sand on high land than in a like deposit on low land. The Illinoian gravel at Mariemont is not higher than 600′ A. T. with the old valley wall rising to 880′–900′ A. T. immediately above it. That on the Lexington pike is at an elevation of 900′ ± A. T., the highest level, thereabout.

3. The ridge of coarse gravel southwest of Covington lies

just where the Licking would have helped build it, if when the Illinoian ice covered the hills to the northeast and to the northwest it had continued to discharge its waters into the re-entrant angle. The angle between the two scallops in the ice border[10] besides the unusual coarseness of the material near the mouth of the Licking suggests this relation. The Anderson Ferry divide must have been almost 900′ A. T. and it is the Illinoian flood which is credited with breaking it. Just upstream from this old divide and near the mouth of a strong northward flowing stream (the Licking) is exactly where such coarse waterlaid material would have been lodged before the divide was actually broken.

4. The smaller area of drift mapped by Dr. Leverett as pre-Illinoian (about a mile and a half north of Crescent Springs) and also the high-level sands around Hebron reported in this paper are north of the border of the Illinoian ice. If these sands and gravels are of early Pleistocene age, it is difficult to picture how the Illinoian ice could have overridden such horizontal and unconsolidated beds without either disturbing them or leaving any boulder clay on top. If the water which deposited the sands and gravels be thought of as contemporaneous with the thinning edge of the ice which left the boulder clay, the picture is less confusing. Dr. Leverett says,[11] "It is a singular circumstance that its apparent south limit and that of the Illinoian drift should be so nearly coincident."

ROCK BENCHES IN THE VICINITY OF CINCINNATI.

Since the sands and gravels discussed here are restricted to high levels, it probably means that at the time of their deposition only those areas were above the drainage lines, which furnishes a strong inference that their age is pre-Illinoian. If we omit the Newport sand at 700′ A. T. which will be referred to again, the deposits described in this paper occur only above 800′ A. T. This would indicate that at that time the drainage was relatively over 400′ higher than the present major streams.

This level is in accord with the elevation of the highest and most prominent rock bench in the Cincinnati region both north and south of the Ohio river. At a glance over the two Cincinnati quadrangles, one is struck by the flat areas inside terrace-like loops of the 820′ or 840′ contour. This level is

[10]Leverett, Frank, *loc. cit.*, p. 15.
[11]Leverett, Frank, *loc. cit.*, p. 41.

even more striking in the field. It can be seen well, for example, all over Devou Park west of Covington where the 820′ level makes finger-like projections toward the Ohio and Licking river valleys. East of the Licking, too, the valley wall rises steeply to about 840′ A. T. where a marked level is apparent. It can also be seen around Dent, three miles northwest of Westwood or along the Ohio river east of the Little Miami river. These last two places are about twenty miles apart, so the level cannot be attributed to any stratigraphic dominance, because the strata rise eastward, at least three or four feet per mile toward the axis of the Cincinnati arch which crosses the Ohio river about 25 miles east of Cincinnati. The Bellevue member of the McMillan formation at Cincinnati has a total thickness of 15 to 25 feet and is not hard to recognize. The level of the top of the Bellevue at the University of Cincinnati is approximately 800′ A. T. Near Dent at a distance of eight miles northwestward from the University the base of a Bellevue outcrop was found by aneroid to be 753′ A. T. If the measurement was accurate this would show a rise of three or four feet per mile in a southeastward direction. It is probably a little greater in a more nearly eastward direction. This 800′–820′ bench is also prominent north of Madeira, near Montgomery, around Reading and in other places in the northern part of the east Cincinnati quadrangle as well as south of the Ohio river in the extreme western part of the west Cincinnati quadrangle. These areas are also separated by as much as twenty miles. Such a level must be older than or of the same age as the Pleistocene water which flooded it and everything higher in this immediate vicinity.

Following this glacial advance which may have been partially responsible for depressing the land surface, there seems to have occurred uplift, possibly due in part to the withdrawal of the load. This causal relation is only a conjecture. The streams evidently entrenched themselves more than 400 feet before the Illinoian advance, but this was accomplished apparently with two interruptions. A second rock bench at about 700′ A. T. is too marked to be missed and another at around 600′ A. T. is less clear but unmistakably a marker for some sort of halt in rejuvenation.

The level of each of these rock benches correlates so closely with evidence of glacial outwash at that level, that the coincidence may be more than accidental. Uplift may have been

checked or actual depression brought about in each case by the advance of an ice sheet and rejuvenation quickened by uplift as the ice withdrew and its load of water was discharged through old or altered drainage lines. The period of outwash building would be a time when a great volume of water was being handled by the drainage and when a great supply of cutting tools was available.

At any rate a marked rock bench is clear in the field or on the map which is around 700′ A. T. and, as said before, there is also a level-topped glacial terrace in the valleys east of Cincinnati which is largely outwash, capped with boulder clay. It is not known to the writer how extended this 700′ A. T., glacial terrace may be found to be and it is only conjecture that it bears any relation to a rock bench of that elevation.

The 700′ A. T., sand at Newport, mentioned earlier, lies on a rock bench and is probably to be assigned to this time of glacial outwash.

In Cincinnati the suburbs of Clifton, Hyde Park, and Avondale are largely built on a 700′+ A. T. bed rock level and overlooking many valleys are prominent 700′+ A. T. spurs. Near Miamitown in the western part of the west Cincinnati quadrangle are good examples and along the Ohio river near Cleves and Addyston. The long spur extending toward the Ohio river between Ludlow and West Covington is another excellent example.

This relation is suggested again in the correspondence between a less widely developed rock bench at an elevation of about 600′ A. T. and the level of the glacial fill in the abandoned valley of the pre-Illinoian Ohio. In both Cincinnati quadrangles it will be found that most of the 600′ A. T. loops in the contours represent glacial material, but in several cases these benches are of bed rock. In one case known to the writer, a single topographic bench is in part bed rock and in part sand. It is between Bellevue and Newport, Kentucky, a 600′ A. T. spur known as the Spinx subdivision. Just west of the suburb of Clifton in Cincinnati there is a prominent ridge extending northwestward toward Cumminsville which is a bed rock bench with glacial material abutting against it. In West Covington there is a small abandoned oxbow of some earlier drainage which carved its stream bed only as deep as 600′ A. T. before it was diverted. There is a 680′ A. T. hill between the bed of the oxbow and the Ohio river on the north. At John's

Hill, about two miles south of Newport, is an abandoned tributary valley at 600′ A. T. The record of drainage at 600′ ± is largely obscured north of the Ohio river by the fact that glacial deposits are of the same elevation. It is possible that this lowest rock bench bears the same relation to the 600′ A. T. Illinoian outwash as that outlined above for the 700′ A. T. bench.

On the other hand it is possible that the two lower benches were cut during a halt in regional uplift due to other causes and that all the glacial outwash came later and bears no relation to the rock benches. However, if the Lake Champlain region has risen 400 feet since the withdrawal of the ice, presumably in response to the removal of load, it does not seem too fanciful to the writer to suppose that the area around Cincinnati may have had its regional uplift interrupted as above conjectured by advancing and retreating ice.

GLACIAL ERRATICS IN KENTUCKY.

Glacial boulders have been reported at many places in northern Kentucky beyond the border of the Illinoian ice, and some of enormous proportions and in baffling topographic positions. Those west of the Licking river are near enough the main drainage lines and low enough in elevation to offer no difficulties in view of the 900′ A. T. gravel near Covington. The largest and the highest are those in the district of the knobs and coal fields of eastern Kentucky. This is in an area south of the old divide at Manchester, Ohio, extending into Lewis, Rowan, Carter, Elliot, and Morgan Counties. A particular boulder at Epworth in Lewis County is reported by Dr. Jillson to be 986′ above sea level and is estimated to weigh 16 tons. A good many others have been reported in that section at around 850′ A. T. One at Farmers in Rowan County weighs about three tons. It is because of these erratics that Dr. Jillson suggested that other evidence of a pre-Illinoian ice sheet in Kentucky might be found, but he reported no boulder clay or other evidence himself.

It seems to the writer of this paper that these erratics, lying as they do just where blocks of ice might have rafted them before the Manchester divide was broken constitute no insurmountable difficulty in the sequence of events. Dr. Leverett thinks the Manchester divide was broken at the time of a pre-Illinoian glaciation by the escape of flooded waters through a col. He thinks, however, that the divide at Man-

chester was not over 850′ A. T. and so the Epworth boulder in particular could not have been rafted to its present position. If it was not carried to the knob where it now is by a floating block of ice, then an ice sheet must have been responsible for the work. However, no boulder clay or other evidence of the presence of an ice sheet has been reported for that part of Kentucky. It seems impossible that an ice sheet capable of carrying such enormous boulders could have over-ridden the region without leaving any other record.

The water-laid material at 900′ A. T. near Covington reduces to 86 feet the discrepancy between the altitude of the highest boulder and other water-laid deposits along the Ohio river. If the outwash near Covington is of pre-Illinoian age, it seems probable that this region was at a lower altitude at the time of this flooding than at present and that the amount of uplift since that time may have been as much as 400 feet. In such an uplift it would be odd if there were no differential shifting of relative elevations over an area as extended as that with which we are dealing (70–75 miles).

It is, therefore, the opinion of the present writer that it is within the range of possibility for the Epworth boulder to have come past the Manchester narrows in a block of ice and that the position of it and of the others on the eastern knobs appears to be a clue to this explanation. At least until further evidence is produced no one can consider that they have been transported by an ice sheet which seems to have left no boulder clay either on the hills or in the valleys. If it is there, we ought to find it.

CONCLUSIONS.

Most of the conclusions in this paper are qualified with alternative possibilities and may be altered after further observations. It has been thought not unprofitable, however, to add the field observations to those reported for the region with the recognition that much more field work is needed before a satisfactory chronology of events can be certain.

1. It is believed by the writer that evidence of a pre-Illinoian ice sheet in northern Kentucky is still lacking—that the glacial material on the uplands south of Cincinnati is water-laid and not icelaid. It seems clear that the material was furnished by an ice sheet (Illinoian or pre-Illinoian) and also by the northward flowing rivers of Kentucky.

2. The sand and sand-and-gravel deposits which occur on most of the land surfaces which are higher than 800′ A. T. in the part of Kentucky which appears on the two Cincinnati quadrangles are thought to correlate in age and manner of deposition. It is thought that all these deposits covering a considerable area are to be referred to Pleistocene damming and that the deposits mapped by Dr. Leverett southwest of Covington are only a part of a more extended area of deposition.

3. The small amount of boulder clay seen imbedded in 30–40 foot deposits of gravel southwest of Covington is thought to have been rafted to its position by water also. The boulder clay is thought to have insufficient areal extent to be significant and entirely too little either vertically or horizontally to represent the spread of an ice sheet.

4. The silt-like material in Devou Park near Covington is reported to have gravel and sand layers and to contain many residual pebbles. It is believed that neither it nor any other deposit near Cincinnati can be called loess. The great numbers of residual pebbles which all the loess-like silt contains seem to preclude wind as the agent of deposition. It is thought to be due to the decomposition of glacial material into which it grades downward.

5. Waterlaid sand at 840′ A. T. at Kennedy Heights overlain by a decomposed boulder clay is reported.

6. A glacial terrace is reported which is 700′–720′ A. T. instead of 600′–660′ A. T. as in the abandoned valley of the old Ohio. Both terraces consist largely of waterlaid material in the lower part, covered with boulder clay. The higher terrace occupies the valleys of the Little Miami and the East Fork, north and east of Milford, Ohio, and the valleys of Dry Run and Cluff creek south of Milford.

7. Three rock benches are reported for this region which show a striking correspondence in elevation with three known stages of glacial outwash. The 820′–840′ A. T. bench is at the same elevation as the lower limit of the old-looking outwash in northern Kentucky. The 700′–720′ A. T. bench corresponds with the level of the higher glacial (Illinoian?) terrace referred to above and the 600′ A. T. bench which is less well developed is at the same level as the top of the Illinoian outwash in the southern part of the abandoned river valleys near Cincinnati. It is suggested that the advance and withdrawal of the load of ice may have had something to do with the halt and renewal

of stream erosion, besides furnishing a great volume of water heavily loaded with tools to do the cutting. An uplift of 400′ ± seems to have occurred between the earlier flooding and the Illinoian advance.

8. If the Manchester divide was broken in pre-Illinoian time, as Dr. Leverett thinks, by the escape of ponded waters, it seems not impossible that the large erratics which are to be found south and a little east were carried to their present position by floating ice blocks. It is suggested that the uplift which followed may have been somewhat differential and that relative elevations have been altered. At least the evidence for an ice sheet seems to be missing.

9. Depth of leaching in gravels of Wisconsin and Illinoian age are reported and also for the glacial material southwest of Covington. The figures are about 4 feet, 14 feet, and 23 feet respectively. One would like the last figure to be larger to make the deposits in northern Kentucky more convincingly ancient. It is suggested that their position would fit the conditions which must have existed in Illinoian time, and that they may, after all, prove to be of Illinoian age. Certainty as to their age seems to depend upon further field observations.

Evolution.

It is widely recognized that the key to the evolution of the vertebrates lies in the study of fossilized skeletal remains. The vertebral column, with its complex structure, its wide variety of types in both living and extinct forms, together with its evolutionary implications held the interest of the distinguished scholar and author of this volume, Mr. Gadow, throughout forty years of his life.

This posthumous volume, edited by J. F. Gaskell and H. L. H. H. Green, discusses in detail the morphology of the axial skeleton and its ontogenetic and phylogenetic modifications in the first part of the book, preliminary to the systemic morphology of the vertebral column in Part II. The author analyzes the complicated mechanisms involved with an understanding born of a life-time study of this subject. He exhibits particular insight in determining homologous and analogous relationships. A great mass of fossil evidence is illustrated and discussed, by which the reader may follow the long tortuous road in the evolution of the Tetrapoda.

The text is a scholarly treatise, comprehensive and masterful. It is well edited. The bibliography is extensive and is indexed in an unique and useful way. It should take its place as an authoritative and valuable reference for the paleontologist and the student of vertebrate evolution.—JOHN W. PRICE.

The Evolution of the Vertebral Column, by H. F. Gadow. xiv 356 pp. Edited by J. F. Gaskell & H. L. H. H. Green. Cambridge, the University Press; New York, The Macmillan Co., 1933. $6.75.

A REVISION OF THE NORTH AMERICAN HOUSE WRENS.

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One of the most interesting and surprising developments of recent ornithological activity in Ohio is the discovery of a new subspecies of the house wren, *Troglodytes domesticus* (=*Troglodytes aedon*). We had so consistently taken for granted that the Ohio house wrens were identical with those from the Atlantic coast of the United States that until recently we had made no comparisons of pertinent material.

The intensive investigations that Dr. S. Prentiss Baldwin and his associates have for several years been conducting near Cleveland in northern Ohio made it desirable, a short time ago, to determine definitely the subspecific status of the northern Ohio house wrens. It was then that we discovered that there was no material in any museum that would settle this question. Not until a good series of breeding birds was collected under the direction of Dr. Baldwin near Gates Mills, in Cuyahoga County, Ohio, where the Baldwin Bird Research Laboratory is situated, was it possible to make the necessary comparisons. An even superficial examination reveals that the Ohio bird is readily distinguishable from both the Atlantic Coast bird and that of the western United States.

The present study has been based primarily on the collections of the Cleveland Museum of Natural History and the United States National Museum; but in the gathering of the specimens necessary to work out the characters and distribution of this hitherto unknown subspecies we have been greatly helped by the authorities of several museums and by individuals as well. These include the American Museum of Natural History, the Philadelphia Academy of Natural Sciences, the Museum of Comparative Zoölogy, the Ohio State Museum, the Zoological Museum of the University of Michigan, the National Museum of Canada, and the Royal Ontario Museum; S. Prentiss Baldwin, J. H. Fleming, P. A. Taverner, L. S. Snyder, J. VanTyne, A. W. Butler, Gus. Langelier, John S. Campbell, S. E. Perkins III, and C. A. Stockbridge.

The following synopsis sets forth the characters and distribution of the North American house wrens. Measurements have been taken as recommended in the recently published manual of the measurements of birds.[1]

Troglodytes domesticus domesticus (Wilson)

Eastern House Wren

Sylvia domestica Wilson, Amer. Ornith., Vol. I, 1808 [after Sept. 1], p. v (description on p. 129), pl. VIII, fig. 3 ([Eastern] "Pennsylvania;" we designate Philadelphia as the type locality).

Troglodytes aedon Vieillot, Ois. Amér. Septen., Vol. II, "1807" [May, 1809], p. 52, pl. CVII (no locality, except "l'Amérique Septentrionale" in title of book; restricted to "Eastern United States," in American Ornithologists' Union Check-List North Amer. Birds, Fourth Ed., October 1, 1931, p. 242; we now designate New York City as type locality, whence Vieillot is known to have obtained ornithological material.

Troglodytes fulvus Nuttall, Man. Ornith. U. S. and Can. [Vol. I] Land Birds, 1832, p. 422, (Bonaparte MS.) (based on the breeding bird of the "Middle States" of the United States; we designate Philadelphia as the type locality).

Troglodytes americana Audubon, Birds Amer., folio, Vol. II, 1833 [about December], Pl. CLXXIX; Ornith. Biog., Vol. II, 1834 [after December 1], p. 452 ("Dennisville" [Maine]; type apparently lost) (nec *Troglodytes americana* Lesson, which, however, is a nomen nudum).

Troglodytes sylvestris Gambel, Proc. Acad. Nat. Sci. Phila., Vol. III, for October [about Nov. 20], 1846, p. 113 (nom. nov. pro *Troglodytes americana* Audubon).

Subspecific Characters.—Colors, especially on the upper parts, sides, and flanks, rufescent and moderately dark; middle of lower surface usually washed with dull buff.

Measurements.—Male: Total length,[2] 117.5–133.5; extent of wings,[2] 165–177.5; wing, 49.5–53.5 (average, 51.3) mm.; tail, 42–45.5 (44.2); exposed culmen, 11.5–13.5 (12.4); tarsus, 16.5–17.5 (17); middle toe without claw, 11–13 (12.2).

Female: Total length,[2] 108–117; extent of wings,[2] 155–171.5; exposed culmen, 11–12.7; tarsus, 16–18 (16.8); middle toe without claw, 11–13 (12.1) mm.

Type Locality.—Philadelphia, Pennsylvania.

Geographic Distribution.—Eastern United States and parts of southeastern Canada. Breeds north to northern New Brunswick, northern Maine, central New Hampshire, Vermont, and central New York; west to central New York, central Pennsylvania, western Virginia and western North Carolina; south to central South Carolina; and east to central South Carolina, central North Carolina, eastern Virginia, Northeastern West Virginia and the Atlantic Coast region north to Nova Scotia. Winters from Georgia, southern Louisiana, and southeastern Texas, south to southern Florida, and to southern Tamaulipas in Mexico. In migration occurs west to western Michigan.

Remarks.—This, the typical form of the species, is the most rufescent of the races. By the separation of the bird from Ohio and surrounding

[1]Measurements of Birds, by S. Prentiss Baldwin, Harry C. Oberholser, and Leonard G. Worley; Scientific Publications of the Cleveland Museum of Natural History, Vol. II, October 14, 1931.

[2]Measured in the flesh by the collector.

areas as a distinct subspecies, the range of *Troglodytes domesticus domesticus* is in summer restricted chiefly to the Atlantic portions of the Eastern United States.

The specific name, *Troglodytes aedon* Vieillot,[3] by which this species has long been known, seems to be antedated by *Sylvia domestica* Wilson,[4] which was based on the breeding bird of eastern Pennsylvania. The former name occurs in the second volume of Vieillot's 'Oiseaux d'Amérique Septentrionale,' which has commonly been cited as published in 1807, the date of the title page. This work, however, it is now known, was published in monthly parts of six plates each, with accompanying text, and the first part appeared in December, 1807. Since *Troglodytes aedon* occurs in the second volume in the text to plate 107 (there are only 124 in the whole work) it could hardly have appeared before May, 1809. Therefore, as Wilson's *Sylvia domestica* was published late in 1808, Vieillot's name ought apparently to be replaced by Wilson's, and the species be called *Troglodytes domesticus*.

The name *Troglodytes americana* Audubon[5] was based on the breeding bird of Eastern Maine, which is the Eastern house wren. A specimen in the United States National Museum has been considered the type, and as such has appeared in print. It bears on its label the following inscription in Baird's handwriting: "Troglodytes americanus? Aud. 2951." On the back of the label in Robert Ridgway's writing are the words "Type of T. americanus Aud." An examination of this bird reveals that while it was a specimen given by J. J. Audubon to Spencer F. Baird, it is not a summer bird such as was the bird from which Audubon made his drawing, but is in fresh autumn or winter plumage, and apparently was one of the specimens later obtained by Audubon at Charleston, South Carolina.[6] A careful comparison of this supposed type with the plate of *Troglodytes americana* in the folio edition of Audubon's Birds of America, clearly shows that it is not the same, but is really an example of the Ohio house wren hereinafter described! Baird evidently did not consider it the type; in fact, he even questioned on the label its identification as Audubon's *Troglodytes americana*. This specimen is thus evidently *not* the type of *Troglodytes americana* Audubon.

Details of the distribution of *Troglodytes domesticus domesticus* at all times of the year may be gathered from the following list of localities from which specimens have in the present connection been examined.

Connecticut.—New Haven (May 9, 1888; May 21, 1878; Sept. 29, 1892); Litchfield (June 4, 1891); Stamford (July 3, 1890); North Milford (July 3, 1892); Sales Ferry (June 28, 1899); East Hartford (May 2, 1891); Windham (May 12, 1902; Sept. 16 and 17, 1891); Newtown (Sept. 23, 1880; Oct. 14, 1881); Fairfield Co. (May 28, 1904).

District of Columbia.—Washington (April 28, 1883; April 28 and 30, 1890; April 20, 1860; May 7, 1889; May 8 and 10, 1891; May 2, 1869; May 1, 1860; June 12, 1858; June 19, 1874; June 19, 1889; July 17,

[3]Ois. Amér. Septen., Vol. II, "1807" [May, 1809], p. 52, pl. CVII.
[4]Amer. Ornith., Vol. I, 1808 [after Sept. 1], p. v, pl. VIII, fig. 3.
[5]Birds Amer., Vol. II, 1833 [about December], pl. CLXXIX.
[6]Ornith. Biog., Vol. II, 1834, p. 452.

1858; July 26, 1888; July 28, 1889; Aug. 19, 1889; Aug. 31, 1896; Aug. 12, 1887; Sept. 9, 1893; Sept. 23, 1889; Sept. 14 and 30, 1894).

Florida.—Gainesville (March —, 1882; Feb. 7, 1890); Miami (Jan. 7 and 18, 1871); East Peninsula opposite Micco (March 5, 1889); Manake, Miakka Co. (Jan. 22 and 23, 1900); San Sebastian (April 7, 1892); Kissimmee (March 4, 1895; Jan. 21, 1901); Cape Sable (Feb. 15, 1918); Trafford (Feb. 5, 1898); Royal Palm Hammock (Jan. 24, 1918); Cape Florida (Oct. 23, 1857); Hibernia (Feb. —, 1870); Brevard Co. (Feb. 25, 1905).

Georgia.—McIntosh Co. (Jan. 7, 1890).

Indiana.—Wheatland (April 27, 1883).

Louisiana.—Pecan Grove (March 9, 1890); Hammond (Nov. 21, 1875); New Orleans (Nov. 2, 1882).

Maine.—No further locality (Spring, 1839).

Maryland.—Marshall Hall (June 6, 1892); Cornfield Harbor (July 24, 1894); Silver Spring (April 29, 1889); Kensington (Sept. 15, 1894; Sept. 15, 1895).

Massachusetts.—Middlesex Co. (May 3 and 18, 1883); Belmont, Middlesex Co. (May 6, 1875; May 6, 1879); Cambridge (June 2, 1892; June —, 1868); near Cambridge (April 23, 1880; May 17 and 31, 1889; June 1, 1892); Brookline (May —, 1857; June 5, 1897); Quincy (June 5, 1879); Medford (June 3, 1890); Watertown (June 16, 1869); Cohasset (no date); Springfield (May 25, 1863); Waltham (June 3, 1874; June 4, 1887).

Michigan.—Kalamazoo (May 27, 1875).

New Jersey.—Duck Island (June 26, 1895); near New York City (June 7, 1890); Crosswicks (Aug. 26, 1895); West Orange (Jan. 13, 1894); Summit (May 13, 1898); Lakehurst (June 6, 1907); Plainfield (April 26, 1871; May 9 and 31, 1871); Pocantico (May 22, 1891).

New York.—Oyster Bay, Long Island (June 24, 1878; May 24, 1874); Glen Cove, Queens Co. (Sept. 8, 1895); Shelter Island (May 18, 1892; Sept. 16, 1887); Staten Island (Aug. 1, 1907); Kiskatom (Aug. 28, 1889); Sea Cliff (July 4, 1904); New York (May 3, 1887; May 14, 1884; Aug. 12, 1890; Sept. 8, 1898; Oct. 1, 1896); Schroon Lake (Sept. 9, 1882); Highland Falls (May 4, 1883; Aug. 9, 1878); Lewis Co. (June 2, 1884); Pearsalls (Nov. 3, 1891).

Ohio.—Cleveland (May 19, 1933).

Pennsylvania.—Gallitzin (June 20, 1890); Altoona (June 19, 1890); Carlisle (June 12 and 24, 1843; July 23, 1844; Sept. 16, 1842); Saltillo (July 9, 1895); Mercersburg (June 20, 1895); Bainbridge (no date).

Rhode Island.—Near Providence (May 14, 1897).

Texas.—Brownsville (Jan. 14, 1911; Feb. 12, 1909); Alice (Oct. 5, 1891); Santa Rosa (Sept. 27, 1891).

Virginia.—Fauquier Co. (Aug. 27, 1901); Short Run, Alexandria Co. (July 29, 1888); Ballston (Aug. 14, 1892); Four Mile Run (April 22, 1894; April 13, 1884); Fairfax Co. (May 10, —; Sept. 6, 1879); Smiths Island (May 19, 1898); Brighton (May 18, 1898); Essex Co. (July 15, 1884); Dunn Loring (April 19, 1891; May 3, 1891); Rosslyn (March 5, 1885; July 15, 1876); Arlington (April 30, 1878; Aug. 8, 1889); Gainesville (May 7, 1887); Barnesville (May 17, 1887).

West Virginia.—Charlestown (July 30, 1898).
Tamaulipas.—Alta Mira (April 8, 1898); Matamoras (Feb. 4, 1902).

Troglodytes domesticus baldwini,[7] subsp. nov.

Ohio House Wren

SUBSPECIFIC CHARACTERS. — Similar to *Troglodytes domesticus domesticus,* but upper parts darker, much less rufescent (more sooty or grayish); the sides and flanks less rufescent (more grayish); rest of lower surface more grayish (less buffy).

MEASUREMENTS.—Male: Total length,[8] 111–133.5 mm.; extent of wings,[8] 160–177; wing, 46–52 (average, 49.6); tail, 38–44.5 (41.6); exposed culmen, 10.8–13.2 (11.8); tarsus, 16–18 (17); middle toe without claw, 11.5–13 (12).

Female: Total length,[8] 108–127 mm.; extent of wings,[8] 157–175; wing, 46.5–50 (48.7); tail, 38–42 (40.6); exposed culmen, 10.5–12 (11.6); tarsus, 16.5–18 (17); middle toe without claw, 11.5–12.5 (12).

The following additional measurements, taken from birds in the flesh, have been furnished by Dr. S. Prentiss Baldwin:

Adult male:[9] Width of bill at base, 3.7–6.4 (average, 4.9); height of bill at base, 3.–4.4 (3.8); width of bill at gape, 6.4–10.5 (7.9); length of head, 18.7–21.7 (19.8); greatest width of head, 13.1–14.8 (14); height of head, 11.1–13.2 (12); length of neck, 18.1–27.8 (23.7); length of sternum, 11.5–14.5 (13); length of body, 23.8–36 (30.3); dorso-ventral diameter of body, 15.1–18.6 (17); breadth of wing, 25.9–42.6 (34.2); length of humerus, 12.7–16.2 (14.4); length of radius-ulna, 14.4–16.8 (15.7); manus, 10.2–14.5 (12.7); femur, 13.4–18 (15.4); tibia, 22.4–25.2 (23.6); inner toe, 5.7–9.2 (7.1); outer toe, 6.2–9.4 (7.3); hind toe, 7.3–9.5 (8.4); claw of hind toe, 4.2–5.8 (5.1); claw of middle toe, 3–4.3 (3.7); length of first (outermost) primary, 15.2–21.8 (18.6); second primary, 28.2–36 (33.2); third primary, 36–41.6 (38.9); fifth primary, 36.7–42.6 (39.8); ninth primary, 42.1–36.7 (39.1); tenth primary, 37–41 (39.1).

Adult female:[10] width of bill at base, 3.5–5.8 (4.7); height of bill at base, 3.2–4.5 (3.8); width of bill at gape, 6.1–10.1 (7.9); length of head, 18.5–20.8 (19.6); greatest width of head, 13.3–14.8 (13.9); height of head, 10.5–13 (11.9); length of neck, 17.5–29.2 (24.3); length of sternum, 8.5–15.8 (12.6); length of body, 26.1–34.3 (30.8); dorso-ventral diameter of body, 11.2–19.8 (16.8); breadth of wing, 27.2–36.6 (33.3); length of humerus, 11.8–16.8 (14.2); length of radius-ulna, 14–16.3 (15.3); manus, 10–13.8 (12.2); femur, 13.1–18 (15.6); tibia, 22–26 (23.5); inner toe, 5.8–8.8 (7.2); outer toe, 5.6–9.2 (7.4); hind toe, 7.1–9.2 (8.4); claw of hind toe, 4.5–6 (5.3); claw of middle toe, 3–4.4 (3.8); length of first (outermost) primary, 16.3–22.7 (18.7); second primary, 30.2–36 (32.5); third primary, 35.3–40.6 (37.5); fifth primary, 35.9–41.3 (38.5); ninth primary, 35.2–40.2 (37.9); tenth primary, 35.5–40.2 (37.4).

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[7]Named for Dr. Samuel Prentiss Baldwin, of Cleveland, Ohio.
[8]Measured in the flesh by the collector.
[9]Thirty-three birds.

The weights given below have been sent also by Doctor Baldwin:

Male:[11] Total weight, 8.6–12.2 (average, 10.8) grams; all feathers alone,[12] 0.502–0.620 grams.

Female:[13] Total weight, 9.6–13.7 (11.5) grams; all feathers alone,[12] 0.517–0.730 grams.

TYPE.—Adult male, No. 27823, Cleveland Museum of Natural History; Gates Mills, 15 miles east of Cleveland, in Cuyahoga County, Ohio, July 29, 1932; S. Prentiss Baldwin.

GEOGRAPHIC DISTRIBUTION.—Central northern United States and adjoining parts of southeastern Canada. Breeds north to central southern Quebec, southeastern Ontario, and central Michigan; west to western Michigan, central northern Indiana, and western Ohio; south to central southern Kentucky; and east to central eastern West Virginia, western Pennsylvania, northwestern and northern New York, and central southern Quebec. Winters from eastern South Carolina, southern Georgia, southern Alabama, southern Louisiana, and central Texas, south to central southern Texas and southern Florida. In migration occurs east to Connecticut, Delaware, District of Columbia, and eastern Virginia; and west to Illinois and Arkansas.

REMARKS.—This is the darkest of the forms of *Troglodytes domesticus*. It is always less rufescent than *Troglodytes domesticus domesticus*, but it has not only a dark sooty phase of plumage but also a lighter, more grayish phase that more approaches *Troglodytes domesticus parkmanii*. This latter phase is apparently not to be regarded merely as the manifestation of intergradation, since it appears in all parts of the range of *Troglodytes domesticus baldwini*.

It is a pleasure to dedicate this new subspecies to Dr. S. Prentiss Baldwin, whose remarkable investigations of the life history of the house wren of Ohio are well known.

The localities and dates of the specimens of *Troglodytes domesticus baldwini* examined are given below.

Alabama.—Orange Beach (Jan. 23, 1911).

Arkansas.—Delight (Sept. 23, 1911).

Connecticut.—New Haven (Oct. 13, 1906).

Delaware.—No further locality (April 23, 1932).

District of Columbia.—Washington (May 5, 1889; Oct. 2, 1889; April 15 and 19, 1891).

Florida.—Wilson (April 7, 1923); Gainesville (Jan. 31, 1887); Istokpoga Lake (March 20, 1923); St. Marks (Dec. 31, 1919); Miami (Nov. 28, 1904); Pensacola (Oct. 30, 1927); Blue Spring (Jan. 17, 1882); Palatka (Jan. 27, 1886); Aucilla River (Jan. 20, 1920); Kissimmee (Jan. 28, 1901); 5 miles southeast of Everglades City, Collier County (Feb. 12, 1932); Amelia Island (Dec. 26, 1905); Eau Gallie (Jan. 31, 1910); Long Pine Key, Royal Palm State Park (Jan. 15, 1924).

Georgia.—Athens (Sept. 24 and 28, 1930; Oct. 7, 1933); Minis Tract, 2½ miles southwest of Savannah (Nov. 5, 1931); Savannah (Feb. 26, 1933); Tifton (Oct. 14, 1931).

[10]Thirty-five birds.
[11]Ninety-five birds.
[12]Less than ten individuals.
[13]Fifty-eight birds.

Illinois.—Rock Island Arsenal (May 16, 1892); Olney (May 8, 1917); Cook Co. (April 29, 1878).

Indiana.—Culver (June 18, 1933); Fort Wayne (about 1873).

Louisiana.—New Orleans (Feb. 24, 1898); Marrero, near New Orleans (Nov. 15, 1932).

Michigan.—Putnam (June 23, 1933); Hartland (May 30, 1933); 7 miles south of South Haven, Van Buren Co. (Sept. 19, 1931); Luzerne (Aug. 12, 1914); Waterloo (Oct. 7, 1922); 7 miles southeast of Jackson (June 27, 1933; July 4, 1933); Brown Lake, Dickinson Co. (July 21, 1909; Aug. 9 and 21, 1909); Charity Island (Sept. 9, 1910); Lovells (Aug. 5, 1931); Vermilion (June 25, 1914); Kalamazoo (April 30, 1906); Ann Arbor (May 10, 1922; June 29, 1933; June 30, 1909; Aug. 8, 1926); Steere's Swamp, Ann Arbor (May 18, 1904); Portage Lake, Washtenaw Co. (May 23, 1933); south of Silver Lake, Washtenaw County (July 4, 1933); Connors Creek, Wayne Co. (Sept. 22, 1906); Greenfield Township, Wayne Co. (May 3 and 23, 1905); Greenfield, Wayne Co. (Aug. 18, 1906; May 5, 1907); Monquagon, Wayne Co. (May 28, 1908); Cadillac (May 9, 10, 14, and 15, 1888); Rush Lake, Huron Co. (July 31, 1908); Sandpoint, Huron Co. (June 11, 1933; June 16, 1908; July 1, 3, and 21, 1908); Birchwood Beach, Berrien Co. (April 29, 1918; May 4 and 9, 1918); Warren Dune, Berrien Co. (May 3 and 28, 1926; June 10, 1926); Harbert (July 9, 1919; Aug. 27, 28, and 29, 1917).

New York.—Staten Island (May 10, 1906); Jamaica (Sept. 14, 1898); Mexico (May 20, —); Wawbeek, Franklin Co. (Aug. 7, 1907; Oct. 1, 1907); Mt. Sinai (Sept. 16, 1907).

North Carolina.—Bent Creek, Pisgah National Forest (April 22 and 23, 1930; May 3 and 6, 1930; April 29 and May 1, 1931; April 21, 23, 27, 28, and 30, May 2 and 5, and Sept. 14, 1932; April 20, 1933); Asheville (Oct. 4 and 9, 1930); Beaufort (May 28, 1932); Beaver Lake, near Asheville (April 24, 1930); Montford Hills, near Asheville (April 24, 1930); Mills River (Oct. 8, 1931); Swannanoa (May 3, 1932; Oct. 6, 1933); Pisgah National Forest (Sept. 19 and 29, 1930).

Ohio.—Gates Mills, Cuyahoga Co. (July 15, 16, 19, 22, 27, 28, and 29, 1932; Aug. 1 and 5, 1932; Sept. 5, 1932; Sept. 8, 1931; June 7, 1925; June 30, 1926); Cincinnati (July 11 and June 29, 1933); Mayfield, Cuyahoga Co. (June 7, 1933); Solon Bog, Summit Co. (June 29, 1933); North Olmstead (May 5, 1924); 4 miles southwest of Toledo (June 28, 1933); 8 miles west of Toledo (June 25, 1933); 3¾ miles southwest of Toledo (June 23, 1933); Buckeye Lake, Licking Co. (May 11, 1928); New Bremen (May 25, 1917; July 2, 1915; July 19, 1916); Pymatuning Swamp, Ashtabula Co. (May 6, 1930; July 22, 1931); Geauga Lake (May 7, 1923).

Pennsylvania.—Calvin (June 7, 1897); Linesville (June 16, 1897); Tionesta (July 7, 1893); Erie (Aug. 1, 1888; Aug. 13, 1877).

South Carolina.—Charleston (Jan. 10, 1891); l'On Swamp, Christchurch Parish (April 22, 1911).

Texas.—Lomita Ranch (Jan. 11, 1881); Sour Lake (March 26, 1905); San Antonio (Jan. 15, 1887).

Virginia.—Smiths Island (May 13 and 14, 1910); Dyke, Fairfax Co. (Sept. 21, 1920); Fauquier Co. (April 18, 1902); Four Mile Run (May 1, 1898).

West Virginia.—Petroleum (April 30, 1874); Davis (June 12, 1897).

Ontario.—Red Bay, Bruce Co. (May 29, 1930); Tobermory, Bruce Co. (Aug. 5 and 13, 1930); Long Point, Norfolk Co. (July 21, 1927; June 8, 29 and 30, 1927); Walker's Pond, near London (Oct. 11, 1887); London (May 11, 1883); Beaumans, Muskoka Lake (Aug. 29, 1904); Streetsville (July 28, 1907); Trenton, Hastings Co. (June 5, 1890); Coldstream (May 17, 1914; May 5, 1913; May 9, 1926; May 11, 1927); Eugenia, Grey Co. (Aug. 22, 1894); Sand Banks, Prince Edward Co. (June 25, 1930); Barrie, Little Lake (June 2, 1932); Point Traverse, Prince Edward Co. (June 30, 1930); Sarnia (Aug. 12, 1899); Orillia (May 12, 1888); Killean, Wellington Co. (Oct. 3, 1904); Hamilton (May 8, 1885; May 8 and 17, 1890; May 11, 1891); Port Sydney, Muskoka Co. (July 5, 1902; Jan. 25, 1898; Sept. 26, 1907); Pottageville, York Co. (June 29, 1933; June 3, 1926; July 12, 1926; Aug. 3, 1926); Point Pelee, Essex Co. (Sept. 8, 1905; Sept. 16, 17, and 24, 1909; Sept. 19, 1906; Oct. 4, 1909; Feb. 10, 1915); Ottawa (Aug. 4, 1919; Aug. 10, 1922; July 27 and 29, 1933); Moose Creek, Ottawa (Sept. 14, 1929); Toronto (June 4, 1890; Oct. 7, 1907; May 26, 1893); Cedarvale Ravine, Toronto (July 18, 1933; Sept. 27, 1929); Fishermans Island, Toronto (May 7, 1928); Agincourt, Toronto (Sept. 23, 1923).

Quebec.—Isle au Canot, Isle aux Grues, near Montmagny (July 19, 1932); Isle aux Grues (Aug. 27, 1929; June 15, 1922).

Troglodytes domesticus parkmanii Audubon

Western House Wren

Troglodytes parkmanii Audubon, Ornith. Biog., Vol. V, 1839 [after May 1], p. 310 ("Columbia River"), (type in United States National Museum).

Troglodytes aedon var. *aztecus* Baird, Review Amer. Birds, September, 1864, p. 138, 139 ("Eastern Mexico, from Rio Grande southward.") (Type from Jalapa, Vera Cruz, Mexico, in United States National Museum).

Troglodytes aedon marianae Scott, The Auk, Vol. II, No. 4, October 20, 1885, p. 351 ("Las Sierras de Santa Catalina, Pima County, Arizona" [in introduction to article]) (type in American Museum of Natural History).

Subspecific Characters.—Similar to *Troglodytes domesticus baldwini*, but much paler, and sometimes more grayish above; sides and flanks paler, rather more rufescent; remainder of lower surface lighter, more buffy.

Measurements.—Male: Total length,[14] 117.5–133; extent of wings,[14] 162–177.5; wing, 49.5–53.5 (average, 51.3) mm.; tail, 42–45.5 (44.2); exposed culmen, 11.5–13.5 (12.4); tarsus, 16.5–17.5 (17); middle toe without claw, 11–13 (12.2).

Female: Total length,[14] 104–119; extent of wings,[14] 152–162.5; wing, 49–52.3 (51); tail, 42–47 (44.8); exposed culmen, 11–12.7 (11.7); tarsus, 16–18 (16.8); middle toe without claw, 11–13 (12.1).

Weight of adult: 7.2–12.5 grams.

Type Locality.—Lower Columbia River near Fort Vancouver (Vancouver) Washington.

[14]Measured in the flesh by the collector.

GEOGRAPHIC DISTRIBUTION.—Central southern and southwestern Canada, central and western United States, and Mexico. Breeds north to central Ontario, southern Manitoba, central Alberta, and central British Columbia; west to southwestern British Columbia, western Washington, western Oregon, and western California; south to northwestern Lower California, southern Arizona, southern New Mexico, central western Texas, central western Tamaulipas, central northern Texas, southern Missouri, southwestern Kentucky, and southern Indiana; and east to southeastern Indiana, eastern Illinois, eastern Wisconsin, northern Michigan and central eastern Ontario. Winters from Arkansas, northeastern Texas, southern Arizona, and central California, south to southern Lower California, Michoacan, Guerrero, Oaxaca, southern Louisiana, and casually to southern Florida.

REMARKS.—This subspecies is even more different from *Troglodytes domesticus domesticus* than from *Troglodytes domesticus baldwini*, since it is so much paler, both above and below, and usually so much more grayish. There are, however, as in *Troglodytes domesticus baldwini*, two color phases, one which represents the extreme of grayness, and another that is much more rufescent brownish above and dull buffy below, sometimes more so than is the gray phase of *Troglodytes domesticus baldwini*. Between these two extremes there is a wide range of variation with many kinds of individual intermediates. In fact, the most grayish examples look different enough from the most buffy and brownish birds to be of a different species. An occasional specimen of the buff-breasted phase strongly resembles *Troglodytes brunneicollis* but without actually bridging the gap between the two species. In any plumage the present subspecies lacks the very rufescent cast of *Troglodytes domesticus domesticus*.

Birds from Brookville and Connersville in southeastern Indiana verge toward *Troglodytes domesticus baldwini*, but are nearer the present form. Those from northern Michigan as far south as Cheboygan County are likewise more or less intermediate but apparently belong here. The considerable series that we have seen from central eastern Ontario indicates that *Troglodytes domesticus parkmanii* ranges east in that region as far as Lake Abitibi and the Algoma District.

Rather surprisingly the house wrens from the Mississippi Valley do not seem to be separable from those of British Columbia and other parts of the Pacific coast region, nor from the birds that breed in Arizona. A re-examination of all our present material thus confirms Robert Ridgway's conclusions regarding this matter.

The localities of the specimens of this race that we have examined are listed below.

Arizona.—Chiricahua Mts. (Sept. 4, 10, and 16, 1932); Fairbank (May 20, 1893); Fort Whipple (May 15, 1865; Sept. 15, 1914); Graham Mts. (May 20 and 22, 1914); Huachuca Mts. (May 19, July 23, 27, and 30, 1932; Aug. 4 and Sept. 29, 1929); Lakeside (July 5, 1915); Lakachukai Mts. (June 19, 1927); Mt. Turnbull (June 10, 1916); Quitovaquito (Jan. 30, 1894); Santa Rita Mts. (July 5, 1884); Topock (Sept. 27, 1917).

California.—Laguna, San Diego Co. (June 21, 1894); Los Angeles (Jan. 16, 1891); Mona Lake (Sept. 16, 1901); New Richmond (Jan. 21, 1923); Panamint Mts (April 11, 1891); San Bernardino (Dec. 28, 1890); San Jacinto Mts. (Aug. 2, 1905); Sierra Nevada Mts. (Aug. 21, 1891); South Yollo Bolly Mt. (July 28, 1905).

Florida.—One and one-half miles west of Everglades City (Feb. 11, 1932).

Idaho.—Albion (Aug. 3, 1910); Blackfoot (July 14, 1890); Edna (June 22, 1910); Florida Mt., Owyhee Co. (June 1, 1932); Malad (July 19, 1911); Shelley (July 30, 1911).

Illinois.—Champaign (April 29, 1933); Hamilton (April 29, 1909); Peoria (no date); Richland Co. (May 25 and 29, 1883; June 2 and 6, 1890); Warsaw (May 6, 1909).

Indiana.—Brookville (April 30, 1887); Connersville (no date); Wheatland (April 20, 1883; May 2, 1885).

Iowa.—Fairfield (May 17, 1890); National, 14 miles west of McGregor (no date).

Louisiana.—Bienville (April 18, 1932).

Michigan.—Bruce Crossing, Ontonagon Co. (Aug. 24, 1931); Burt Lake, Cheboygan Co. (July 6, 1932); 12 miles northeast of Ironwood (July 11, 15, 17, 23, 25 and 26, 1932); McCargo Cove, Isle Royale (May 29, 1930); Montreal River, Gogebic Co. (Aug. 26, 1931); Porcupine Mts., Ontonagon Co. (July 24 and 25, 1904).

Minnesota.—Carlton Co. (July 9, —); Fort Snelling (May 15, 1890; May 9, 16 and 27, 1891; June 3, 1903); Minneapolis (no date).

Mississippi.—Bay St. Louis (Oct. 8, 1898).

Missouri.—Willow Springs (Oct. 4, 1892).

Montana.—Thompson Falls (July 26, 1895).

New Mexico.—Magdalena Mts. (Aug. 30, 1909); Riley (Sept. 22, 1905); Rio Puesco (Sept. 6, 1905).

North Dakota.—Larimore (June 28, 1915); Sweetwater (May 17, 1902).

Oregon.—Portland (June 23, 1897).

South Carolina.—Port Royal (Jan. 29, 1891).

Texas.—Atascosa County (April 24, 1933); Cameron County (April 20, 1890); Corpus Christi (Jan. 22, 1887); Guadalupe Mts. (Aug. 21, 1901); Hempstead (no date); Kerrville (May 2, 1889); Nueces Bay (Dec. 1, 1891); 10 miles east of Pleasanton (Jan. 8, 1933); Rice, Navarro Co. (Sept. —, 1880); San Antonio (April 11, 1889; April 15, 17, and 18, 1890; Feb. 5 and 6, 1890).

Washington.—Port Angeles (July 23, 1921); Vancouver (June —, 1835).

Wisconsin.—Bridgeport (May 27 and 29, 1912); Danbury (May 27, 1919); Mather (May 25, 1918); Mamekagon Lake (May 31, 1919); Orienta (June 14, 1919); Mellen (June 10, 1919); Outer Island (July 9, 1919); Potosi (June 5 and 6, 1912); Rib Hill (July 3 and 9, 1918); Solon Springs (Aug. 1, 1919).

Alberta.—Eight miles northwest of Red Deer (July 13, 1896).

British Columbia.—Comox (June 1, 1895); Cranbrook (May 10, 1914); Lund (July 16, 1897).

Manitoba.—Gypsumville (May 26 and 28, 1931; June 8, 1931).

Ontario.—Echo Bay, Algoma Dist. (July 15, 1931); Laird (June 9, and 15, 1931); Big Fork, Rainy River (July 16, 1929; Aug. 3, 1929); Emo, Rainy River (June 8, 12, 17, 20, and 27, 1929); Clearwater, Rainy River (July 5 and 8, 1929); Lake Abitibi (July 7, 8, and 10, 1925); MacLennan (July 4, 6, 7, and 22, 1931); Weatherbee, Lake Nipigon (June 27, 1924).

Chihuahua.—Batopilas (Oct. 4 and 5, 1898).

Hidalgo.—Tula (Mar. 9, 1893).

Michoacan.—Zamora (Jan. 24, 1903).

Nuevo Leon.—Monterey (Feb. 7, 1891).

Puebla.—Metlaltoyuca (Jan. 19 and Feb. 19, 1898); Tehuacan (May 4, 1893).

Sonora.—Alamos (Jan. 4, 1899).

Tamaulipas.—Alta Mira (April 12, 1898); Camargo (Jan. 9, 1902).

Vera Cruz.—Orizaba (no date).

Physical Science.

The purpose of this book has been set forth in the preface by the authors, stating that it "is intended for an orientation course in Physical Science." It contains some twenty chapters devoted to the subjects astronomy, geology, meteorology, chemistry, classical physics and modern physics. In addition there are four appendices of units, atomic weights and physical constants. In short, it is a new book on general science. As a book introducing general science it is, of course, written in a most elementary fashion, describing quite accurately, however, many of the phenomena which one observes in nature; as accurately perhaps as one can describe such things without enlisting the aid of elementary arithmetic or algebra. It is printed on good glossy paper, bound durably in cloth, and has the appealing feature of many clear and descriptive diagrams.

When the reviewer was a freshman in high school a text similar to this was used in general science. It seems deplorable that our institutions of secondary education have degenerated to levels that demand the use of such a book in our colleges and universities.

HAROLD H. NIELSEN.

College Physical Science, by McCorckle and Lewis. ix+327 pp. Philadelphia, P. Blakiston's Son & Co., 1934. $2.00.

The Preparation of Scientific Papers.

This book is a splendid guide to the efficient writing, revising and illustrating of articles for publication in scientific journals. The right and wrong methods of presenting subject matter, tabular material, bibliographies and illustrations are all carefully described and illustrated. Much time, trouble and disappointment would be saved if all authors would carefully read and follow the excellent suggestions given here. The book should be in every scientific library and on the personal shelf of every author.—L. H. S.

The Wistar Institute Style Brief. 169 pp., paper covers. Philadelphia, The Wistar Institute Press, 1934.

ECOLOGICAL STUDIES OF *ARGIA MOESTA* HAGEN (ODONATA: COENAGRIONIDAE) BY MEANS OF MARKING.

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INTRODUCTION.

These studies were carried on during the summers of 1931 and 1932 along the Olentangy River about three miles north of Worthington, Ohio, and on the western portion of the Brown Fruit Farm, which borders the east side of the river at this point. It was noted at the outset that the different sexes and color forms of *A. moesta* seemed to occur in different proportions in different parts of the area studied; and the appearance of distinct color forms gave the impression that this species might be polychromatic, as a few species of dragonflies seem to be, or the color forms might be merely an indication of the age of the adult, as is the case with most of the color variations in adult dragonflies. In order to throw some light on the activities of this species, its distribution over the area, and the nature of its variation in color, considerable collecting was done along the river and on the western portion of the fruit farm. A system of marking was devised so that individual specimens could be recognized if recaptured and hence data concerning their movements and activities could be obtained.

Argia moesta Hagen.

According to Williamson (6)[1] there are five geographic variations in the color pattern of the males of this species. The form with which this paper deals is that described as Type II by Williamson, or as *putrida* by Hagen (5). Detailed descriptions of this form are given by Byers (1, 2), Garman (4), Hagen (5), and Williamson (6).

The adults in any given locality show distinct variations in general color. The color pattern of the thorax and abdomen consists of two colors, black and a lighter color. The black, except possibly in the male, comprises only a small portion of the body surface, and the general color of the insect is due to

[1]Numbers in parentheses refer to the bibliography at the end of the paper.

the shade of the lighter color. Females may appear brown, blue, or entirely black. The older blue and dark individuals often have narrow light stripes on the mesepisternum just laterad of the dorsal carina. Both the blue and dark females may appear pruinose, but the pruinescence is confined to the ventral side of the thorax. The dark and some of the older blue females seem to be about equally pruinose. Males may appear brown and black, blue and black, or entirely whitish (pruinose). Teneral specimens of both sexes are pale brown and soft-bodied, and the color pattern is not distinct. Rarely the pale areas of the thorax of the female appear streaked with brown and blue or blue and dark; occasionally the pale areas of the male appear intermediate in shade between brown and blue, or between blue and white (when the pruinescence is rather light).

Adults in tandem are frequently encountered along riffles. A single pair may remain in tandem for considerable time if undisturbed, during which it will fly back and forth along the riffles, alighting occasionally on such vegetation as water willow or on rocks. Oviposition occurs while in tandem; in this process the female thrusts her abdomen completely under water, so that the wings usually float on the surface. The eggs are deposited on submerged vegetation. The adults are not confined to the riffles, but frequently fly some distance from them. In doing so they prefer sunny situations to shaded ones, but prefer grassy areas or the edge of woods to bare areas.

AREA WHERE WORK WAS DONE.

This area, located along the Olentangy River and the western portion of the Brown Fruit Farm, is shown by the accompanying map (Fig. 3). The fence along the north side of the area is on the county line between Delaware and Franklin counties. The fruit farm lies between the two fences.

The river, as it flows south opposite the fruit farm, is shallow and rocky, and contains numerous riffles and water willow. The west bank is lined by trees, mostly willow, elm, and sycamore, beyond which there is a wide flood plain occupied by a golf course (the Mt. Air Golf Course).

Along the east side of the river is a high bank, varying in height from 50 to 80 feet, on which there are numerous outcroppings of shale. For the most part this bank drops steeply to the river's edge, but on the southeast and to a lesser degree on the northeast portion of the farm the steeper slope retreats

from the water's edge, giving way to a typical flood plain. Several steep-sided ravines cut back from the river into the woods and orchard.

The woods shown on the map consists chiefly of oak and hickory near the top of the high bank, and farther east of beech and maple. Two strips of varying width, the "air drains," have been cut through the woods between the river and the orchard to improve air drainage in the orchard. The vegetation in these air drains is for the most part not more than three or

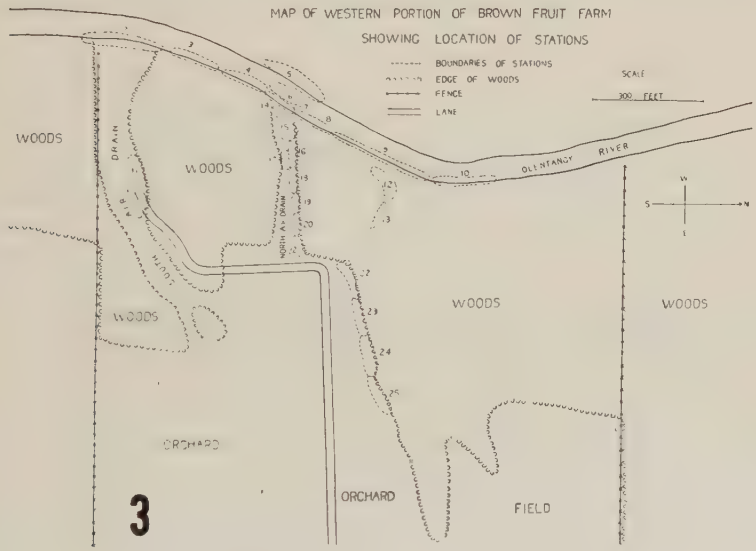


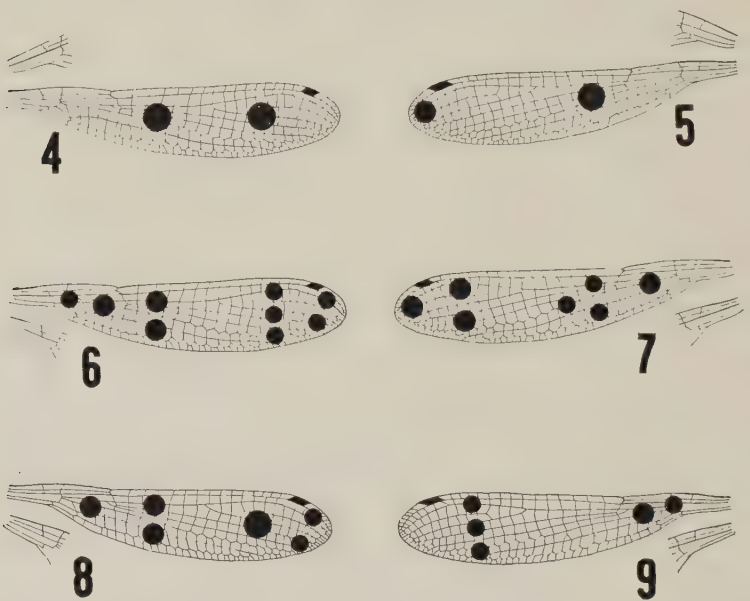
FIG. 3. Map of the area where the work was done.

four feet high, and consists of tree seedlings, shrubs, and herbaceous plants that have persisted from the woods or which have come in from the orchard. The orchard is an apple orchard, with the grass and weeds beneath the trees cut close to the ground.

Stations.—In order to facilitate the recording of data, that part of the area where the collecting was done was divided into 25 "stations," the locations of which are shown on the map. Station 1, which is not shown, is along a set of riffles about 250 yards south of the southern boundary of the farm. There are no riffles opposite stations 2 and 3, and very few opposite 9. Station 6 is along the riffles in the middle of the river opposite the north air drain. Station 14 is on the steep bank just below the west end of the north air drain.

MARKING.

Most of the experiments in marking insects mentioned in entomological literature have consisted of marking lots of insects and releasing them at some central point to determine their range of dispersion. The marking was usually done by applying some sort of stain, ink, paint, or enamel to the insect with an atomizer or spray gun. In only a few cases, notably the experiments with bees by Von Frisch (3), have insects been marked so that individual specimens could be recognized if recaptured; in such cases the marking was usually done with



FIGS. 4 TO 9. Figures illustrating the method of marking.

Fig. 4. No. RH0110.
Fig. 5. No. LH0101.
Fig. 6. No. RF2232.
Fig. 7. No. LF1321.
Fig. 8. No. RF1212.
Fig. 9. No. LF2030.

a small brush or stick. As far as the writer is aware, no marking experiments of any sort have been carried out on dragonflies.

In this study, specimens of *Argia moesta* were marked on the ventral surface of the wings with dots of india ink, a different combination of dots being put on each insect. The ink was applied with a small pointed stick. The dots were placed at one or more of four different positions on the wing, and the number of dots placed in each of these four positions made a four-figure number which was the identification number of

the insect marked (see Figs. 4 to 9, inc.). By this method a great many different combinations can be devised, and records can be kept of a large number of individual specimens.

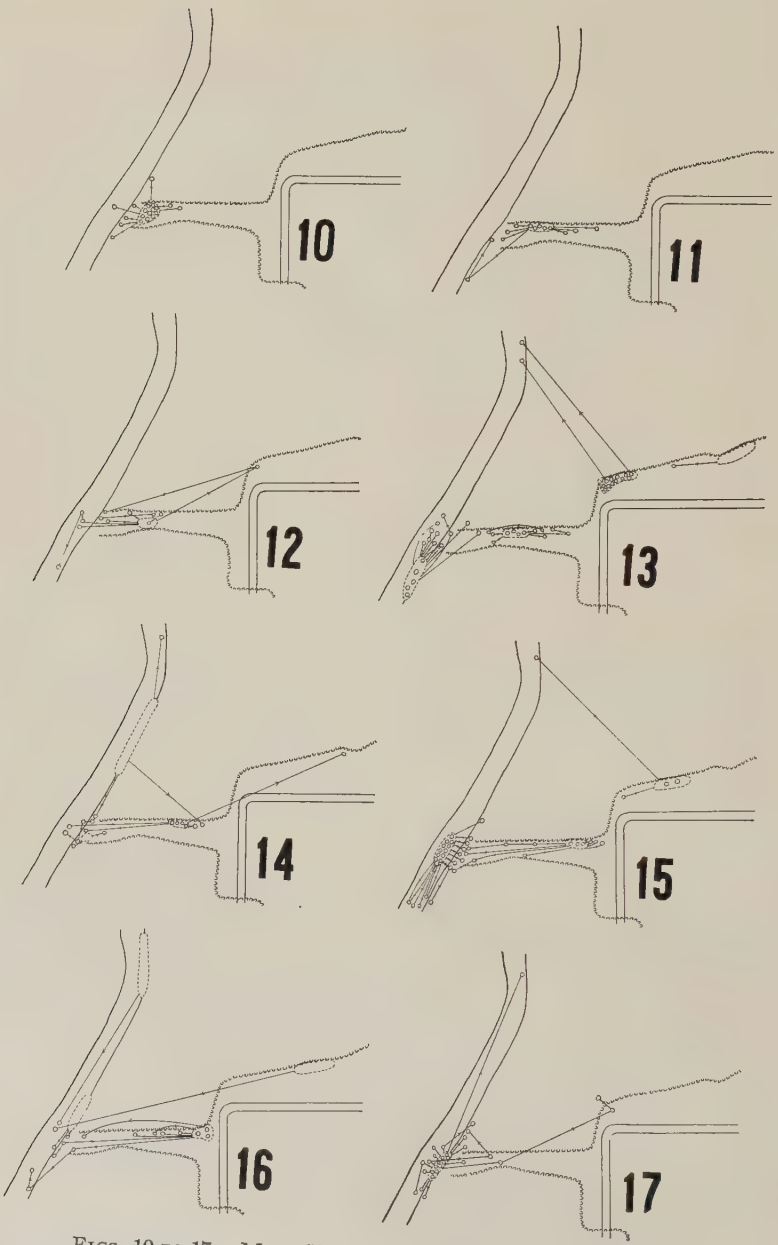
Little difficulty was experienced in applying the ink to the wings, and the insects were in no way injured by the treatment. The marking was done in the field where the insects were captured, and the insects were released immediately after marking. This method worked very satisfactorily, and individuals recaptured as long as 24 days after being marked still retained the marks on their wings distinct enough to be read. In cases of returns where the marks were partly rubbed off so that there was a question as to the identity of the specimen (such cases were relatively few), the record was discarded.

DATA.

Marking Data.—During the two seasons a total of 830 specimens of *A. moesta*[2] were marked, of which 178 (21.5%) were recaptured. Many of these were recaptured more than once; thus a total of 227 recaptures was obtained. These returns have brought out some interesting facts concerning the movements, color change, and length of adult life of this species.

Movements.—The movements of this species, as indicated by the recaptures of individuals marked at 18 of the 25 stations, are shown graphically by the maps in Figs. 10 to 17, inclusive. There is quite a bit of movement upstream and downstream for short distances, but only a few cases of individuals flying for any great distance up- or downstream. There is considerable movement of individuals to and from the river, chiefly via the air drains. A large proportion of the recaptures (93 out of the 227) was obtained in the same station in which the specimens were marked, indicating that many individuals remain in one locality for a considerable length of time. Movement from one station to another is apparently rather slow. Of the specimens taken along the edge of the woods and orchard (stations 22 to 25), some seem to have come from the river via the air drain, while others may have come through the woods from further upstream (see Figs. 13 and 15).

[2]During these two seasons 77 specimens representing 9 other species of Odonata were also marked. These species, with the number of individuals of each marked, are as follows: *Argia sedula* Hagen, 32; *Hetaerina americana* Fab., 27; *Argia apicalis* Hagen, 7; *Ischnura verticalis* Say, 3; *Enallagma exsulans* Hagen, 2; *Plathemis lydia* Drury, 2; *Sympetrum vicinum* Hagen, 2; *Argia violacea* Hagen, 1; *Libellula luctuosa* Burm., 1. Only six returns from these were obtained, four being *H. americana* and two *A. sedula*. The returns were obtained after from two to seven days; they indicated very little movement, and no color change.



FIGS. 10 TO 17. Maps Showing Movements of Individuals.

These maps represent the central portion of the area shown in Fig. 3; the scale is the same. Each map shows the recaptures obtained from individuals marked at one or more stations. The stations where the individuals were marked are indicated by broken lines; the small circles indicate points of recapture; the lines connecting the circles to the marking station show the direction of movement. Circles within the marking station indicate recaptures in the station where the

Color Change.—The data concerning color change may be summarized as follows:

	Records	Maximum No. of Days
REMAINING THE SAME COLOR:		
Brown (males and females)	22	6
Blue (males and females)	71	24
Pruinose (males)	39	24
Dark (females)	3	4

	Records	Days Elapsing
CHANGING COLOR:		
Brown to blue (males and females)	24	2 to 19
Brown to dark (females)	3	13 to 16
Brown to pruinose (male)	1	18
Blue to dark (females)	15	2 to 15
Blue to pruinose (males)	2	4 to 5
Dark to blue (females)	11	2 to 9
Blue to dark, then black to blue (females)	2	2 and 4 to 15 and 19

Color in the males seems to be directly correlated with age, the brown individuals being the youngest and the pruinose ones the oldest. In the females the brown individuals are the youngest, and the blue and dark individuals the oldest; since they may change from brown to blue in two days and from brown to dark in apparently not less than 13 days, it would seem that the brown individuals turn blue first and later turn dark. Since dark individuals may turn blue again, it appears that the dark condition is, in most cases at least, only temporary. The fact that practically all the dark females were taken along the riffles in tandem with males suggests that possibly the dark color is brought about by certain internal phenomena correlated with sexual maturity.

Length of Adult Life.—This can be deduced from the data given in the table above. Although some individuals remained brown for 6 days, most of the recaptures of brown individuals

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individuals were marked. In some cases, recaptures of individuals marked at two or more stations are shown on the same map. Due to the limitations of space, not all the recaptures obtained are shown, but those shown are typical.

Fig. 10. Recaptures of individuals marked at station 15.
Fig. 11. Recaptures of individuals marked at station 16.
Fig. 12. Recaptures of individuals marked at station 17.
Fig. 13. Recaptures of individuals marked at stations 4, 18, 22, and 25.
Fig. 14. Recaptures of individuals marked at stations 9, 14, and 19.
Fig. 15. Recaptures of individuals marked at stations 6, 20, and 23.
Fig. 16. Recaptures of individuals marked at stations 8, 10, 21, and 24.
Fig. 17. Recaptures of individuals marked at station 7.

were obtained after only 1, 2, or 3 days. Most of the recaptures of blue (female) and pruinose (male) individuals were obtained after periods considerably shorter than 24 days. The maximum length of adult life is about four weeks, the average probably being about three weeks.

Population Data.—During the seasons of 1931 and 1932 a total of 1,542 records of *A. moesta* were obtained, as compared with 402 records of 24 other species of Odonata.[3] Of the 1,542 records, 545 were obtained along the river, 789 in the air

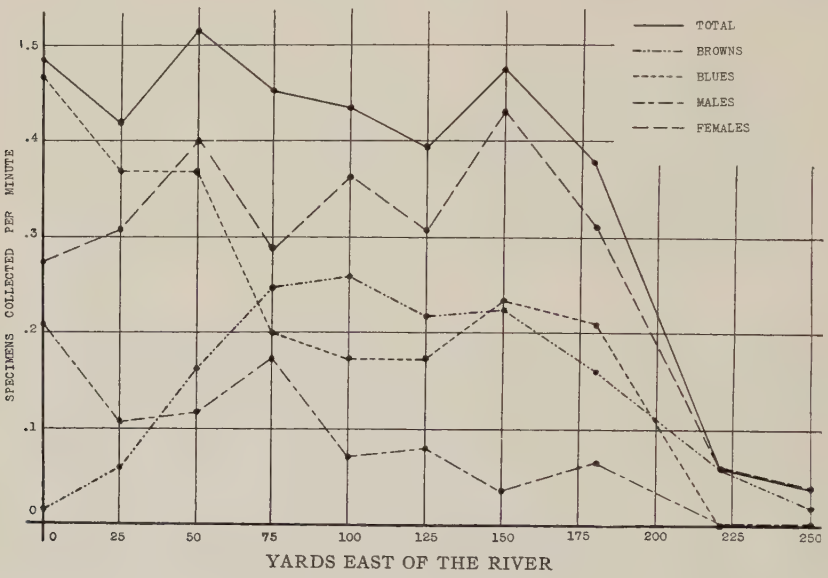

FIG. 1. Graph showing the relative abundance of sexes and color forms along and east of the river (1932).

drains, 54 in the woods, and 154 along the edge of the woods and orchard. No specimens were taken east of station 25. The analysis of these records has brought out certain facts regarding the sex ratio, distribution of sexes and color forms, and daily abundance of this species.

Sex Ratio.—During both seasons the females were more abundant than the males. In 1931 the ratio was 31.41% males and 68.59% females; in 1932 it was 32.73% males and 67.27% females. There are thus more than twice as many females as males.

[3]The Odonata of the Brown Fruit Farm, as observed by the writer during these two seasons, are discussed in a paper to be published in the near future in a bulletin of the Ohio Biological Survey.

Distribution of Sexes and Color Forms.—The relative abundance of the different sexes and color forms along the river and at different distances east of it in the north air drain and orchard is shown graphically in Fig. 1. In this graph relative abundance has been indicated in terms of specimens collected per minute. The increased abundance of the blue (older) individuals along the river is undoubtedly due to the fact that mating and oviposition, activities of only the older individuals, take place there. The increased abundance of individuals at 150 yards

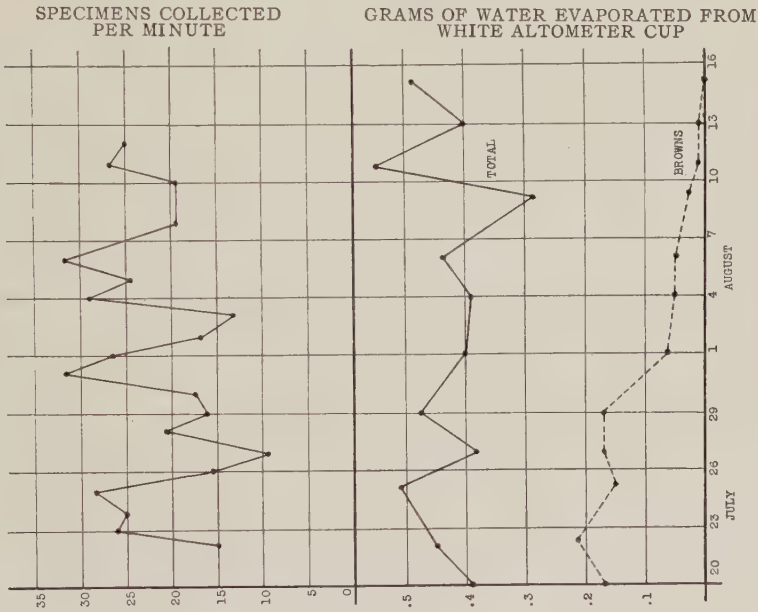

FIG. 2. Graph showing the relative daily abundance and evaporation data (1932).

from the river (the end of the air drain and the beginning of the orchard) is probably due to the fact that some of the individuals taken there (stations 21 and 22, particularly 22) came from the river by way of the air drain, while others came through the woods from further upstream.

Daily Abundance.—The relative abundance of all adults, the relative abundance of brown adults, and the evaporation data, for the season of 1932, are shown graphically in Fig. 2. It is interesting to note that the relative abundance of brown individuals, and consequently the rate of emergence of adults, decreased during the period of observation. Another interesting

point, which the graph does not show, is that the abundance of individuals in the air drain and orchard fell considerably near the end of the period of observation. During August most of the collecting was done along the river, where the individuals were most abundant; hence the relative abundance of all adults does not decrease with the decrease in rate of emergence.

During the two seasons various meteorological data were obtained, but none showed much correlation with dragonfly abundance except evaporation data. It will be noted from the graph that in general, periods of high evaporation are characterized by increased abundance. However, this increase is probably only apparent, due to the increased activity of the insects during these periods.

An attempt was made, using the information obtained from marking and collecting data, to calculate the actual daily population of *A. moesta* on the area. The calculations were based on the relative number of marked individuals recaptured on successive days, with allowances made for shifts in population due to movements in and out of the area and to death and emergence. Such calculations indicate that the daily population is probably several hundred.

Only a small fraction (never more than 100) of the total population was ever taken on any one day. This may have been due to the way in which the collecting was done, viz., time was taken to mark practically all individuals taken; or to the fact that the entire area was not worked each day; or many individuals may simply have been overlooked, due to their habit of remaining for long periods perched on some exposed leaf.

DISCUSSION.

Since no brown individuals except some very teneral ones were taken along the river, it would seem that within a few hours after emergence, as soon as the body hardens sufficiently, the adults fly away from the river, up into the woods or air drains. There they remain for several days, feeding and moving from place to place rather slowly. In some cases they do not seem to move more than 25 yards in two or three days. General movement, as from one station to another, is not to be confused with rate of flight. Individuals of *A. moesta* may fly quite rapidly at times, but the results of this study indicate that they do not fly rapidly for any great distance, but remain for a considerable time in the same locality (station). By the time

the adults are a week or ten days old, they move about a little more rapidly. They may return to the river for a time, and then fly back into the air drains. Females fly up into the air drains to a greater extent than males.

When the adults are about 14 days old they return to the river and mate. This species is rather promiscuous in its mating; a single female may mate with several different males, or a single male with several females. Only the older individuals mate. The males by this time are almost or entirely pruinose; the females are only pruinose ventrally, and are dark laterally and dorsally. After mating, the pruinose males remain white, but the dark females may become blue again. The older blue females thus seem to be individuals which have ceased laying eggs. These older blue females, often with muddy abdomens and wings, may fly back into the air drains again; the males after mating may fly to the top of the high bank, but never go as far from the river as do the older females. The adults of both sexes may live a week or more after the first mating.

Most of the movement that occurs is to and from the river via the air drains; there is relatively little movement upstream or downstream. During wet and cool weather the adults are more or less inactive, and spend most of the time perched on vegetation near the river. During high water, when the water willow is flooded, the older adults are forced up into the air drains.

The peak of abundance for this species is during the latter part of July. By the middle of August there are no more brown individuals present, indicating that emergence has ceased. Although no collections were made after August 15, it is quite likely that by the middle of September all the adults would have disappeared from the area.

SUMMARY.

These studies were carried out along the Olentangy River about three miles north of Worthington, Ohio, during the summers of 1931 and 1932. Collections were made of *A. moesta* in different parts of the area, and a system of marking was devised so that individual specimens could be marked and their activities studied. The method of marking consisted of applying different combinations of dots of india ink to the wings by means of a small pointed stick. During the two

seasons 830 individuals were marked, of which 178 (21.5%) were recaptured, from 1 to 24 days after being marked. From the recaptures of these marked individuals, and from collecting data, numerous facts were disclosed concerning the activities of this species.

The adults do not fly very far, and their movement from place to place is rather slow. Most of the movement is to and from the river; there is relatively little movement upstream or downstream. The adults undergo a definite color change during their life; they are brown for a few days after emergence, then they become blue and later pruinose; the males become entirely pruinose and appear whitish, while the females are only pruinose ventrally; at the time of mating the females become dark dorsally and ventrally, but may turn blue again later. The adults live three or four weeks after emergence.

The ratio of males to females is about 1 : 2; the two sexes occur in almost equal proportions along the river, but away from the river the females are much more abundant. Brown individuals are scarce along the river and at a considerable distance from it, but are fairly abundant about 100 yards from the river. Blue (older) individuals are most abundant along the river. During the season, periods of high evaporation seem to be accompanied by increased abundance. Calculations based on marking and collecting data indicate that the daily population of this species on the area studied is probably several hundred, although less than 100 were collected any one day. This species is distinctly a sun-loving insect, but shows no pronounced distaste for vegetation.

BIBLIOGRAPHY.

1. **Byers, C. Francis.** A contribution to the knowledge of Florida Odonata. Univ. of Florida Pub. No. 1, pp. 173–175. 1930.
2. **Byers, C. Francis.** Argia Rambur. In "A Handbook of the Dragonflies of North America," by J. G. Needham et al. C. C. Thomas Pub. Co., Springfield, Ill., pp. 284–286, 297–298. 1929.
3. **Frisch, Karl von.** Aus dem leben der bienen. Berlin, J. Springer. 1927.
4. **Garman, Philip.** The Zygoptera or damselflies, of Illinois. Bull. Ill. St. Lab. of Nat. Hist., Vol. XII, Art. IV, pp. 507–510. 1917.
5. **Hagen, H. A.** Synopsis of the Neuroptera of North America. Smiths. Rept., pp. 94–96. 1861.
6. **Williamson, E. B.** The dragonfly Argia moesta and a new species (Odonata). Ent. News, 23: 196–203. 1912.

SOME ANCIENT COSMOGONIES AND EVOLUTION.

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Far too often the academician, like the layman, classes the rich mythology of the ancients with the modern animal stories and the fairy tales of children. Thus he dismisses the strifes, woes and victories of ancient deities as being outlandish tales of anthropomorphic gods whom no one, in these days of enlightenment, propitiates or entreats, and whose memory would be buried in eternal oblivion were it not for musty books and inquiring scholars. Why consider ancient mythology? Is not much of it fragmentary. and even that which we have often inconsistent? Have not numerous myths been vitiated and frequently modernized with each copying? All this, we admit, is very true. We are often perplexed! However, there is one error in the above view; there is one thought which the critic has not grasped. A myth is more than a tale that is told. for in it, with its poetic language and personified and deified forces of nature, rests the thought—the profound thought—of the ancients. These legends are not the epics of an individual, but the poetry and philosophy of a race.

We point with pride to the progress we have made in our control over nature—to the speed with which we travel, the ease with which we communicate with those at a great distance and the quality and quantity of the goods which we are able to produce. And yet, we forget the momentous discovery which primitive man made when he discovered the principle of the wheel—the cog which plays so large a part in our mechanized civilization. Truly this principle—the idea of a primitive man—is more fundamental to civilized life today than it ever has been. Have we improved much upon the principle of the wheel, or have we merely applied it?

Just as we have noted the importance of a primitive (but momentous) discovery for our present-day civilization. so also may we find in the realm of thought certain ideas which have been held through the ages as more or less fundamental. This is most certainly true with regard to ideas of origin and development, as numerous writers, including the present writer,[1] have

[1]Dudycha, G. J. "What Is Evolution?" *Scientific Monthly*, 29: 317–332, October, 1929.

pointed out. Unfortunately, however, we have too long neglected the more ancient ideas of origin and have begun with the Greeks, as though they were the first to speculate concerning the profound problem of how-did-things-come-to-be-what-they-are. In the case of the ancient Egyptians and Babylonians we found, when we divested their ancient legends and myths of their theological implications and deity names, that they held as fundamental certain ideas which were strikingly like, and which antedated, those of the Greeks.[2] In the present article, we shall try to search out diligently the ideas of origin as found among the ancient Indians and Iranians, and see if their ideas bear any likeness to the ideas of the Greeks or to more modern ideas of development and evolution with which we are familiar.

When we turn to the ancient sources of the Indian and Iranian ideas of origin we encounter some difficulties. We can not ascribe the various books and hymns to particular writers, as we can in the case of the Greeks. Nor can we ascribe a definite date to these writings.

To discover the ancient Indian ideas of origin, we turn to the ancient or Vedic period of their literature. To this period belong the four Vedas of which the most ancient, the *Rigveda*, is the most important. *Rigveda*, which may be translated as Verse-Wisdom, is sometimes characterized as the "book of psalms," for it consists chiefly of lyrics in praise of the various gods. This ancient collection of Verse-Wisdom of India consists of a little over one thousand hymns which are grouped in ten books of varying length. The tenth book, which contains the material in which we are primarily interested, appears quite definitely to have been written at a later date than that of the writing of the first nine. Since the whole of this collection of Verse-Wisdom was not written at one time but over a longer or shorter period, a particular date can not be ascribed to the composition of the hymns. Nor is it easy to place these hymns roughly for they were perpetuated orally through numerous generations. Scholars who have studied the literature of the Vedic period most carefully are not in complete agreement as to the approximate date of the composition of the hymns of the *Rigveda*. Hopkins in discussing the approximate date of the composition of the Verse-Wisdom of India says: "One

[2]Dudycha, G. J. "Ideas of Origin Among the Ancient Egyptians and Babylonians," *Scientific Monthly*, 32: 263–269, March, 1931.

thousand B. C. is, then, not the lowest, but the highest limit that we can reasonably set to the Rig Veda, and 800 B. C. is probably nearer the mark, as far as the bulk of the Rig Veda is concerned."[3] Another scholar, Macdonell, agrees with Hopkins.

Professor Das, however, another authority who has studied the subject very carefully, presents a different theory as to the period to which the *Rigveda* belongs. He has gone to the hymns themselves and has compared various statements found there, with astronomical, geological and cultural facts which have been calculated to belong to a very early period of cultural history. On the basis of his studies, he concludes: "Taking the lower estimate as correct, it would not be unreasonable to guess that some of the Rigvedic hymns were as old as 25,000 years."[4] The arguments which Das gives in support of his theory seem sound and quite convincing. If he is correct in his interpretations and comparisons, then the ideas of origin found in the sacred literature of ancient India antedate those of the Greeks and even those of the ancient Egyptians and Babylonians by many millenia.[5] Let us turn to these primeval ideas and discover how the ancient Indians viewed the problem of how-did-things-come-to-be-what-they-are.

First we shall consider the more mythological notions, and later those which are more definitely philosophical. According to ancient Vedic ideas, the world was divided into three parts—earth, atmosphere and sky or heaven—each of which was represented by a god. When the universe is referred to, however, Dyavaprthivi ("Sky and Earth") is the name which is used. Sometimes one god, and at other times all the gods are said to have created heaven and earth and all things. And again, heaven and earth are said to be the parents of the gods. This paradox, that the gods created heaven and earth which are their parents, apparently was not confusing to the ancients, but merely enhanced for them the mystery of creation. This paradox is not merely peculiar to the earlier mythological notions, but is also found incorporated in the later philosophical ideas. This self-contradiction they avoided in part, however, by declaring *Aditi* as the mother of the gods—the Primordial

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[3]Hopkins, E. W. "India Old and New," p. 30, New York, 1901.
[4]Das, A. C. "Rigvedic Culture," p. 35, Calcutta and Madris, 1925.
[5]See Dudycha, G. J., *ibid.*

Force of Nature. Thus we read in the seventy-second hymn of the tenth book of the *Rigveda:*

THE HYMN TO BRAHMANASPATI, X, 72.

The genesis of the bright gods
We will declare with wonder deep,
Uttered in hymns for him who shall
In coming generations hear.

Brahmanaspati like a smith
Together forged whatever is;
When gods existed not as yet,
Then being from non-being rose.

In times when gods existed not,
Then being from non-being rose,
The spaces of the world were born,
From her they call Uttanapad.

The earth was from Uttanapad
Born, and the spaces from the earth;
From Aditi arose Daksha,
Again from Daksha Aditi.

Born first of all is Aditi,
Who, Daksha, thine own daughter is;
After her were the gods produced,
The blessed and immortal ones.

When ye stood in the swelling flood,
Ye gods, who well established are;
Then as from dancers from you whirled
Upward in mighty clouds the dust.

When ye like mighty athletes caused
The worlds, ye gods, to emanate,
Then lifted ye the sun on high,
That in the ocean hidden lay.

Eight valiant sons had Aditi,
Who from her body were produced.
With seven she went among the gods,
While she the egg-born cast away.

With seven sons went Aditi
Up to the ancient race divine;
The egg-born she surrendered to
The sway of birth and now of death.[6]

[6]Taken from Griswold, H. DeW., "Brahman: A Study in the History of Indian Philosophy," pp. 27-28, New York, 1900.

Here we find a number of significant ideas expressed. In the second stanza, we find the idea of design in the universe, for we are told that even before the gods existed "Brahmanaspati like a smith together forged whatever is." Before the gods existed, who preceded the rest of creation, all creation was determined. Also we note that non-being and being are not held as in opposition to each other, but the former is considered as the source or root of the latter—from non-being comes being. And in this process we have a process of becoming for the "spaces of the world" were born. This process of becoming is suggested elsewhere, as we shall see. In the fourth stanza we have a paradox—"from Aditi arose Daksha, again from Daksha Aditi"—but in the fifth it is brushed aside by definitely stating that Aditi was "born first of all." Aditi means "Unbinding" or "Boundlessness." This is especially significant for it immediately suggests to us Anaximander's idea of "the boundless" as the source of all things. Again we find this same idea among the Egyptians, for Neb-er-tcher was believed to be an almighty and invisible power which filled all space—an indefinable, boundless something from which all things issue. Thus Aditi comes to be merely the Indian label for an idea which we find in the thought of various peoples of different ages and different lands.

In the sixth and seventh stanzas, we find two significant ideas expressed. First, the idea of the primacy of water, "the swelling flood," which was before the gods were established and from which they came. This idea, a most common idea, we have encountered elsewhere. It suggests Nu, the watery abyss of the Egyptians, and the ancient Sumerian myth which holds, "Then we created the gods in the midst of their waters." It suggests Thales, the Ionian, Aristole, the Peripatetic, as well as the modern biologist. Whether 3,000 or 25,000 years old, this is truly an ancient idea. A second idea which we find here is that of activity—a creative force. "Then as from dancers from you whirled upward in mighty clouds of dust," the things created, and even the sun which "in the ocean hidden lay" was lifted up on high. There was activity, a creative force, in the primal mass from which all things have their being. Is this a new idea to us? We can hardly say that it is. The reference to Aditi as the egg-born, found in the last stanza, we shall refer to later.

In another hymn, Rigveda X, 82, we find the idea that the

whole of creation evolves out of the creator himself—first the gods and then all animate and inanimate things which are produced by the creative force with the assistance of the gods. Besides the idea of the primal watery mass, which existed even before the creator was born, which we have noted in other Vedic hymns, we have here another idea which we shall observe again in another connection, namely, that of the "embryo in which all the gods were aggregated." In the beginning, in the primitive embryo were all the gods contained in potential form and hence the whole of creation. Hence things come to be what they are by some process of unfolding, of making manifest that which was potential, and all according to some design which we forged "when gods existed not." This idea may rightfully be labeled "evolution." In another hymn (Rigveda X, 121) we encounter essentially the same idea. Here is described a "Golden Germ" as creator of heaven and earth, of the waters and all that lives.

What time the mighty waters came, containing the universal germ, producing Agni,
Thence sprang the gods' one spirit into being. What god shall we adore with our oblation?
He in his might surveyed the floods, containing productive force and generating Worship.
He is the god of gods, and none beside him. What god shall we adore with our oblation?
Ne'er may he harm us who is earth's begetter, nor he whose laws are sure, the heaven's creator,
He who brought forth the great and lucid waters. What god shall we adore with our oblation?[7]

In the preceding Vedic hymns which we have considered, we noted that the ideas of origin are set forth, by and large, in terms of the gods and sacrifices—mythology. In the last hymn which we shall consider, Rigveda X, 129, the famous philosophical hymn—the Hymn of Creation—we shall note that mythology has passed into philosophical speculation. This famous hymn, which contains some passages that are still difficult to render, embraces the essential mythological notions which we have been considering, but sets them forth in a more abstract and philosophical manner. Macdonell presents the following rendering:

[7]Gray (Editor), "The Mythology of All Races," Vol. VI, Keith, "Indian," p. 51, Boston, 1917.

HYMN OF CREATION, X, 129.

Non-being then existed not nor being:
There was no air, nor sky that is beyond it.
What was concealed? Wherein? In whose protection?
And was there deep unfathomable water?

Death then existed not nor life immortal;
Of neither night nor day was any token.
By its inherent force the One breathed windless:
No other thing than that beyond existed.

Darkness there was at first by darkness hidden;
Without distinctive marks, this all was water.
That which, becoming, by the void was covered,
That One by force of heat came into being.

Desire entered the One in the beginning;
It was the earliest seed, of thought the product.
The sages searching in their hearts with wisdome,
Found out the bond of being in non-being.

Their ray extended light across the darkness:
But was the One above or was it under?
Creative force was there, and fertile power:
Below was energy, above was impulse.

Who knows for certain? Who shall here declare it?
Whence was it born, and whence came this creation?
The gods were born after this world's creation:
Then who can know from whence it has arisen?

None knoweth whence creation has arisen;
And whether he has or has not produced it:
He who surveys it in the highest heaven,
He only knows, or haply he may know not.[8]

This hymn, unlike some that we have considered, does not begin with a god nor even a creator, but begins by emphasizing the idea that before creation began nothing existed, not even non-being—"non-being then existed not nor being"—save "That One" who "breathed breathless then in self-existence" and "other than it of any kind, there was not." Let us note well that this source-of-all-things, in this hymn, is not labeled as a god, but is merely referred to as the "One" or "That One"—the "It" which has no beginning. The source of creation, according to this Vedic hymn, is impersonal. As we read on, we find that all was darkness, and by darkness covered; all was in a watery chaos. In this void, however, something

[8]Macdonell, A. A. "Hymns from the Rigveda," pp. 19–20.

was becoming; That One by his own generative force came into being—the potential became actual. Another rendering of these lines is: "A germ lay hidden in its secret casing, which by the might of heat was born as That One." Here again we find the same cosmogonic notion which we encountered as "embryo" in Rigveda X, 82, and as the "Golden Germ" in Rigveda X, 121. Is it not significant that these ancient Indians held this notion of the potentiality of all things in a primordial seed or germ from which all things come by a process of becoming? Also let us remember that this notion is not peculiar to Vedic cosmogony; we have encountered this idea before. The ancient Egyptians believed that in Nu, the great watery abyss, all things were in a "state of helpless inertness" from which they were freed by becoming actual. For Augustine, also, all things were potential in an original germ or seed from which all things come. It is this potentiality of forms in the primordial mass which seems to be common to all of these concepts.

In the beginning the One had desire, the product of thought, which was the first seed and the bond of non-being and being. Thus ideas preceded creation and brought being from non-being. Also "creative force was there, and fertile power" which worked itself out into the actual. The hymn ends emphasizing the unity of the creative force, but also with the question: Who knows for certain whence came this creation?

Now that we have an idea of the ancient Vedic ideas of Origin, let us turn to the ancient Iranians and survey their cosmogonic ideas.

For a knowledge of the ancient Iranian ideas of origin, we turn to the *Zend-Avesta*, the sacred books of the Parsis, which is really a collection of fragments of varying antiquity. Of these sacred books, the first part, often called the Avesta proper, contains the Vendidad, which is a compilation of religious lore and mythological tales; the Visparad, which is a collection of litanies for the sacrifice, and the Yasna which is a collection of litanies and also includes the five hymns or Gathas. Just as we have found, when we considered the Indian Vedas, that scholars are not agreed as to the date of the Vedic hymns, so also in the case of the *Zend-Avesta*, scholars differ as to what dates are to be ascribed to the sacred books of Parsis.

Dr. Haug assigns a not much later date than 1200 B. C. to the Gathas, and fixes that of the much larger part of the

Vendidad at 900 or 1000 B. C. Pike, however, thinks "that the Gathas are much older, even, than that, and perhaps older than the Rig Veda." He says:

> Cauis Plinius the Second, tells us, in the Thirtieth Book of his Natural History, that Eudoxus said that Zarathustra lived 6,000 years before Plato (who was born 429 years before Christ); and that so it is asserted also by Aristoteles. Hermippus, Pliny informs us, who made a diligent study of the works of Zarathustra, explaining an immense number of verses, stated that he lived 5,000 years before the Trojan War (which is supposed to have taken place about 1,190 years before Christ).[9]

In the *Sacred Books and Early Literatures of the East*, however, the date for the Gathas is placed about 2000 to 600 B. C., and that for the Vendidad at 600 to 400 B. C. If Pike is right, then the *Zend-Avesta* is a source of ancient ideas which date back to around 6000 B. C., and thus are around 8000 years old. Thus we are about to examine some ancient ideas of origin, some of which may antedate those of the *Rigveda*, which together with the Vedic notions were derived from still more ancient Aryan ideas.

The Iranian account of the creation is found in the first Fargard of the Vendidad. In this account, we find an opposition between Ahura Mazda, also called Ormazd, the creator of the good, and Angra Mainyu, also called Ahriman, the creator of that which is evil. Ormazd was conceived as living in a region of infinite light, and Ahriman as living in an abyss of endless darkness. When Ahriman came from the abyss and beheld the light of Ormazd, there was a conflict between the two. As Ormazd created excellent lands, Ahriman tried to despoil his work by bringing into being various plagues.

We find in the *Zend-Avesta* significant ideas which throw much light upon the ancient Iranian ideas of origin. In one place we are told that after Ahura Mazda had created his creatures which were to remain "three thousand years in a spiritual state, so that they were unthinking and unmoving, with intangible bodies" then Angra Mainyu came from his abyss into the light of Ormazd and a conflict continued between them for three periods of three thousand years each, or a total of nine thousand years. Thus Zoroastrian cosmogony really covers a period of twelve thousand years. During the first period of conflict, Ormazd was dominant; during the second

[9] Pike, A. "Lectures of the Arya," p. 8, Louisville, 1930.

period, a period of bitter conflict, material things were created in the order: heaven (including heavenly bodies), water, earth, plants, animals and man; during the third period, the evil spirit spread disease and corruption in the good creation, but finally Ahriman and his hosts were driven back to hell. This dualism and conflict is characteristic of all Zoroastrian beliefs.

It has been pointed out that the spiritual creations of the first period of three thousand years—the period of the creation of the spiritual creatures of Ormazd—are remarkably like the "Ideas" of Plato. Again we may note another parallel. The conflict between Ormazd and Ahriman suggests the doctrine of Empedocles, who posited two world forces, love and hate, which were in conflict, and the triumph of love over hate was the cause of organic evolution. The same idea may be found among the Semites for whom creation was the result of a conflict in which order emerged out of chaos because of the personal triumph of the creator.

Sometimes these two opposing primeval spirits are referred to as twins, but this is not correct. Although Ahura Mazda is the good principle and Angra Mainyu the evil principle, the conflict is essentially between Cpenta-Mainyu the beneficent mind—the Good Mind—and Angra Mainyu. Since Cpenta-Mainyu is an emanation from Ahura Mazda, Ahura is above both Cpenta-Mainyu and Angra Mainyu. If this were not the case, the Evil Spirit would be equal with Ahura Mazda, and thus Ahura would not be the supreme Lord of Creation. Thus behind or beyond this conflict which results in material creation is Ahura Mazda whom the *Zend-Avesta* does not attempt to define. Ahura Mazda was conceived as existing without beginning or ending, and that his essential characteristic was that he thought. "He never *began* to exist, so He never began to *create*. To *think*, with Him, is to *create*, and being, mind, intellect, wisdom, He never *was*, nor could be, without thought; to think, to exist, and to create, are with Him one and the same." Thus in the Gathas we find the doctrine clearly expressed, that the universe is the uttered thought of God. We find further, that although Ahura Mazda is transcendent, he is also immanent in his creation and manifests himself in the material world.

We may say, then, that Zarathustra, the writer of the Gathas, conceived Ahura Mazda as the Infinite and Eternal One, the Creator, who although transcendent is immanent,

the Pure Light who did not create darkness but which the absence of light occasions. "By withdrawing Himself and His outflowing, He gave occasion for the darkness, which thus existed co-eternally with Himself, and uncreated like Himself, the twin of Cpenta-Mainyu, but not of the same father." Ahura Mazda, thus, must be conceived as the light—the hidden light—for if he had created light, or if his own existence had had a beginning, the darkness would have pre-existed eternally. Since this is not the case, Ahura Mazda remains supreme as the Eternal One, the source of creation whose thoughts becoming actual are the material world.

Thus we find that the Iranians believed that the source-of-all-things is fundamentally a unity which, although itself uncognizable, makes itself manifest through its emanations. It is further significant that they believed that the essential nature of that from which all things come is thought.

Since we have examined carefully and in detail the ideas of origin found among the ancient Indians and Iranians, let us here recapitulate the significant ideas which we found. Although the Vedic hymn, the "Hymn of Creation" (Rigveda X, 129), is the best source of ancient Indian ideas of origin which is available, we found significant ideas in other Vedic hymns even though they were couched in mythological terms. One of the first things which we encountered in our study was a paradox, found not only in the more mythological hymns but in the "Hymn of Creation" as well, as to which came first, the gods or Heaven and Earth. Sometimes the former are spoken of as creating the latter, and at other times as having been created by the latter. This paradox, however, was brushed aside by making Aditi, the Primordial Force of Nature, the source of all things. Aditi, we found, means "boundlessness" or the Boundless One, which immediately suggests Anaximander's idea of "the boundless" and the Egyptian Neb-er-tcher.

Again we found the idea of design expressed, for before the gods existed "Brahmanaspati like a smith together forged whatever is." Thus being from non-being came, and by some process of becoming, for the "spaces of the world" were born. The primacy of water we found was emphasized again and again. Certainly "the swelling flood" which was before the gods were established and from which they came, reminds us of Nu, the watery abyss of the Egyptians, of Thales, who posited water as the source of all things, of the Semites, of

Aristotle, and of the modern biologist. In this primal mass, a creative force lay hidden, an "embryo in which all the gods were aggregated"—the "Golden Germ" or egg—from which all things came by some process of becoming, a process by which that which was potential became actual. This idea of the potentiality of all things in an original germ was held by Augustine. The Egyptians labeled this idea Nu.

In the "Hymn of Creation," we found the tone more philosophical than mythological. Here we found the source-of-all-things to be conceived as impersonal—the "That One" or the "It" of creation. We also found here emphasis laid upon the watery chaos, the darkness, from which "That One" came into being. Here also was creative force or power which manifested desire, the product of thought, which brought being from non-being. Thus thought is given a fundamental place in the Indian ideas of origin.

When we turned to the Iranian ideas of origin, we found conflict to be a fundamental idea, an idea which is not only peculiar to the mythological tales, but is likewise characteristic of the more philosophical notions. This conflict, a conflict between good and evil, resulted in the creation of the material world. Empedocles, we are reminded, posited love and hate which were in eternal conflict, which conflict resulted in the whole of creation. The Semites, likewise, conceived of two opposing world forces which were responsible for creation. Again the Iranians conceived Ormazd as light—the Pure Light. This suggests, among other ideas, the Egyptian "Vision of Hermes" in which the cry of light was symbolized as a flame—the primacy of fire.

Thus we must note in closing, that we have been dealing with ancient ideas of origin which antedate those of the Greeks, and which are not so far different in many respects from those which we have been accustomed to attribute to the originality of the lovers of wisdom of the Golden Age of Greece. We have discovered, as a result of our careful inquiry, that there is a peculiar, yet interesting, resemblance between the ideas of origin of the Ancients and those of Western thinkers. Many of the notions which are characteristic of the evolutionary thought of the nineteenth and twentieth centuries are also found, as we have pointed out above, in the cosmological speculations of the ancients.

THE EXTERNAL MORPHOLOGY OF ACRONEURIA EVOLUTA KLAPALEK.

(Perlidae, Plecoptera.)

ROBT. L. CLARK.
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Stone flies are very primitive insects. Due to their poorly developed breathing apparatus the immature forms live largely in well-aerated water. This study was made principally at Stone Laboratory, Gibraltar Island, Put-in-Bay, Ohio, and the specimens used were collected along the rocky shores of the Lake Erie Archipelago, where the waves dashing upon the rocks furnished sufficient oxygen for their development.

Acroneuria evoluta is one of the medium sized varieties of the stone flies, the females having a length to tip of wings of 35 to 37 mm. and an expanse of 60 to 64 mm.; males, length to tip of wings, 25 to 28 mm., expanse, 42 to 48 mm. This genus is distributed over a wide area, being found in all parts of the United States and Canada.

Realizing the importance of muscle attachments, the writer hoped to include such a discussion in this paper, but due to the season of the year in which this work was done and the correspondingly scarcity of material, it was impossible of accomplishment. That phase will be taken up in a later paper.

This study was suggested by and made under the direction of Professor C. H. Kennedy, of Ohio State University, to whom the writer owes sincere thanks for his many helpful criticisms and suggestions. Thanks are due, also, to Professor R. E. Snodgrass, who looked over the drawings and helped in the naming of some of the parts.

The Head.

(Pl. I, Figs. A, B, C, D, E.)

The head of *Acroneuria evoluta*, family *Perlidae*, is wider than the prothorax, rather blunt in front at the labrum, and bears two long antennae. There is a dark area over the clypeus and also over the ocellar triangle. The frontal ridge is in the form of a broad letter "M." The head is capable of receding somewhat under the anterior edge of the pronotum. (Pl. I, Fig. A.)

The tentorium is braced in the back by two posterior tentorial arms, and extending forward from these are two arms which fit into the

lobes above the antennae and support the frontal region of the tentorium. (Pl. I, Fig. B.)

The head appendages.—The labrum is flatly rounded in front and is covered with short hairs. The mandibles in the adult are poorly developed. The maxillae consist of sharp distigalea, lacinia, five-jointed palpus, stipes and cardo. The labium bears two three-jointed palps, between which are the paraglossae and glossae. These proceed out from the mentum. The antennae consist each of approximately seventy segments, the basal joints being brown, followed by yellowish and darker segments toward the tips. The ocelli form an almost equilateral triangle, the hind ocelli quite larger than the fore, and closer to each other than to the eyes. (Pl. I, Fig. A.)

The Thorax.

(Pl. I, Figs. 2, 3, and Pl. II.)

The prothorax is entirely covered dorsally by a plate-like pronotum. The pronotum is quadrangular, wider than long and narrows somewhat behind. The rugosities are rather strong and are yellow in a darker background. Attached ventrally to the side edge of the pronotum is the anopleura, to which articulates the trochantin. (Pl. I, Fig. 2.) The coxa lies directly below the trochantin. The prosternum is composed of the basi-sternum, furca-sternum and spini-sternum. These are fused together into more or less of a rigid plate. The furcal pits are inclined toward the center and are joined in front by a furcal suture. (Pl. II, Fig. 8.) The two furcal spines (sternal apophyses, Pl. II, Fig. 5) are so wide apart that they do not appear as a median organ as in higher insects.

The mesothorax extends forward dorsally to beneath the posterior edge of the pronotum by means of a prescutum which bears on the front a phragma. (Pl. I, Fig. 3.) The prealare (Figs. 2, 3, 4, 6, 7, "Pa") extends down the side of the prothorax, almost touching the anterior edge of the episternum. In the membrane of the pleurum, between the prothorax and the mesothorax, lies the mesothoracic spiracle. (Pl. I, Fig. 2, "Sp2.") The mesopleurum is crossed obliquely by a heavy pleural suture (Pl. I, Figs. 2, 4), the lower end of which articulates with the coxa. Anterior to and below the pleural suture lies the episternum, posterior and above lies the epimeron. By a finer suture, reaching the pleural suture at right angles the episternum is divided into an an-episternum and a kat-episternum. (Pl. I, Fig. 2.) The small anterior sclerite of the an-episternum, known as the pre-episternum (Pl. I, Fig. 2, "PEps.") adjoins the prealare. At the base of the wing are several small plates and fused with the episternum is a crescent-shaped sclerite or basalare. (Pl. I, Figs. 2, 3, 4.) Posterior to this in the membrane are two plates, known collectively as the subalare. (Pl. I, Figs. 3, 4.) The wing articulates with the thorax by the anterior and posterior notal wing processes. (Pl. I, Figs. 3, 4.) The shield-shaped mesosternum consists of precoxal pieces on the sides with a basi-sternum, furca-sternum and spini-sternum in the center. The furcal pits are inclined toward the center as in the other two thoracic segments and are connected by the furcal suture. The

trochantin extends down from the pleurum and articulates with the coxa. A presternum lies in the membrane anterior to the mesosternum. (Pl. II, Fig. 5.) Both the prosternum and mesosternum bear narrow processes which lie in the membrane posterior to each. (Pl. II, Fig. 5.) Lying posterior to the mesotergum is a postnotum which is fused with the tergum and extends laterally to the epimeron. (Pl. I, Fig. 2 and Pl. II, Fig. 6.) The postnotum bears a phragma posteriorly.

The metathorax bears a spiracle (Pl. I, Fig. 2, "Sp3") which lies in the membrane anterior to the metapleurum. The heavy pleural suture divides the pleurum into an episternum and epimeron. The sclerites at the base of the hind wing are the subalare, basalare and the anterior and posterior notal wing processes. The postnotum of the metatergum bears the posterior phragma. (Pl. II, Fig. 6.) The sternum of the metathorax is similar to that of the mesothorax except there is no sharp process in the membrane posterior to it.

The wings.—Among the species of the genus Acroneuria there is considerable variation in the number of crossveins in the outer submarginal fields of the wings, some having many and others none. In the forewing the cubito-anal crossvein is close to the apex of the anal cell. There are three anal veins unbranched, with two simple veins extending from the anal cell below. (Pl. III, Fig. 9.) As in all genera of the order the radial sector of the hind wing at its base is fused with the median vein instead of the radius. The second anal vein is four-branched. (Pl. III, Fig. 9).

The legs of adult stone flies, being similar to those of the immature forms, extend laterally from the side of the body when the insect is at rest, and are adapted for clinging to the surface of stones. Each leg has three tarsal segments. The terminal one is longest and carries on the end an oval pad and two sharp claws.

The Abdomen.

There are ten distinctly recognizable abdominal segments. All but the first are slightly hardened and are more or less cylindrical in shape. In each the tergite and sternite are closely fused at the sides, forming a narrow fold. Segment one is greatly reduced, appearing merely as a small rectangular dorsal sclerite. The pleural region of segment one is replaced by the attachment of the hind legs, and the ventral sclerite is lacking, being completely fused with the metasternum and the sternite of segment two. A surviving trace of an eleventh segment is found in the supra-anal plate of the female and the sub-anal lobes of the male. These will be discussed further as a part of the genital region."

The Genital Organs.

(Pl. III, Figs. 10 to 17.)

There are ten abdominal segments, the ninth segment in the male bearing on its dorsal side an oval, transverse, polished hammer; and on the tenth segment, between the cerci, two subanal lobes modified into sharp, cylindrical, genital hooks. (Pl. III, Figs. 10, 11.) These extend forward ventrally to the middle of the tenth segment. The

abdomen is covered with short hairs and on the ventral surface of each of segments nine and ten are two patches of short spines. The penis extends from the end of the abdomen as in figure fourteen.

"The eighth ventral segment of the female is produced in the middle into a rather narrow subgenital plate which reaches half way across segment nine. The plate is slightly emarginate behind and having slight emarginations on the sides of the plate at the base."[1] At the end of the abdomen of the female, between the cerci, is a supra-anal plate which is a triangular protrusion of segment ten covering the anal cavity above. (Pl. III, Figs. 15, 16, "SAP.") Between the cerci are the subanal lobes or paraprocts. (Pl. III, Fig. 15, "Papt.") The cerci bear nineteen segments.

BIBLIOGRAPHY.

Comstock, J. H. and **Kochi, C.** 1902. The Skeleton of the Head of Insects. Amer. Nat. 36: 13–45.

Crampton, G. C. 1917. A Phylogenetic Study of the Lateral Head, Neck and Prothorax Regions in some Apterygota and Lower Pterygota. Ent. News, 28: 398–412.

1926. A Comparison of the Neck and Prothorax Sclerites throughout the Orders of Insects. Trans. Amer. Ent. Soc. 52: 199–248.

1917. The Nature of the Veracervix or Neck Region in Insects.

1914. A Ground Plan of a Typical Thoracic Segment in Winged Insects. Ent. Lab., Mass. Agri. Coll., Amherst.

1914. Notes on the Thoracic Sclerites of Winged Insects. Ent. News, 25: 15–25.

1918. A Phylogenetic Study of the Terga and Wing Bases in Embids, Plecoptera, Dermaptera and Coleoptera. Psyche 25: 1–12.

1932. A Phylogenetic Study of the Head Capsule in certain Orthopteroid, Psocoid, Hemipteroid, and Holometabolous Insects. Bull. Brook. Ent. Soc., 27: 19–55.

Handlirsch, Anton in Kekenthal, Willy and **Krumbach.** 1930. Handbuch der Zoologie. vierterband Progoneata, Chilopoda, Insecta. 669–678. Berlin and Leipzig.

Martin, J. F. 1916. The Thoracic and Cervical Sclerites of Insects. Ann. Ent. Soc. Amer. 9: 35–83.

Needham, J. G. and **Claassen, P. W.** 1925. Plecoptera of North America.

Smith, Lucy W. 1917. Studies of North American Plecoptera. (Pteronarcinae and Perlodini.) Trans. Amer. Ent. Soc. 43: 433–489.

Snodgrass, R. E. Morphology and Mechanism of the Insect Thorax. Smith. Misc. Coll., Vol. 80, No. 1.

Morphology and Evolution of the Insect Head and its Appendages. Smith. Misc. Coll., Vol. 81, No. 3.

Tillyard, R. J. 1921. A New Classification of the Order Perlaria. Can. Ent. 3–11.

1923. The Stoneflies of New Zealand. Order Perlaria. Trans. New Zealand Institute.

1926. Insects of Australia and New Zealand. Chapt. 13. Sidney, Australia.

Walker, E. M. 1922. The Terminal Structures of Orhtopteroid Insects. A Phylogenetic Study. Part II. The Terminal Abdominal Structures of the Male. Ann. Ent. Soc. Amer. 25: 1–76.

1931. On the Anatomy of Grylloblata compodeiformis Walker. Ann. Ent. Soc. Amer. 24: 519–536.

Weber, Hermann. 1933. Lehrbuch der Entomologie.

Wu, C. F. 1923. Morphology, Anatomy and Ethology of Nemoura. Bull. Lloyd Library, 23: 1–81.

[1] "Plecoptera of North America," by Needham and Claassen.

EXPLANATION OF PLATES.

Plate I.

Fig. 1. A, Head, dorsal view. B, Same as above, posterior view. C, Maxillae, showing five-jointed palps. D, Mandible. E, Labium.
Fig. 2. Lateral view of thorax region.
Fig. 3. Ventral surface of mesotergum and upper pleural regions.

Plate II.

Fig. 5. Inner surface of mesotergum.
Fig. 6. Inside view of metatergum showing anterior and posterior phragmas.
Fig. 7. Dorsal view of thorax.
Fig. 8. Ventral view of thorax.

Plate III.

Fig. 9. Wings of *Acroneuria evoluta*.
Fig. 10. Ventral view of segments 8, 9 and 10 of the male, showing genital hooks.
Fig. 11. Tenth segment, male, showing genital hooks, posterior view.
Fig. 12. Lateral view of segment 9, male.
Fig. 13. Same as above, posterior view, showing hammer.
Fig. 14. End of abdomen, male with penis extended.
Fig. 15. End of abdomen, female, ventral view, showing subanal lobes (paraprocts), and supra-anal plate.
Fig. 16. Segment 10, female, ventral view, showing supra-anal plate as a part of the segment.
Fig. 17. Sternum of segment 8, showing genital plate.

ABBREVIATIONS USED.

AEps.....an-episternum
An.....Anus
ANP.....anterior notal wing process
APL.....anapleura
Ba.....basalare
Bs.....basisternum
Cer.....cercus
Cx.....coxa
Dg.....distigalea
Epm.....epimeron
Eps.....episternum
Fs.....furcal suture
Gl.....Glossa
h.....genital hook
ha.....hammer
KEps.....kat-episternum
Lc.....lacinia
Pa.....prealare
Papt.....paraproct
PEps.....pre-episternum
Pgl.....paraglossa
Ph.....phragma
PlS.....pleural suture
PN.....postnotum
PNP.....posterior notal wing process
pmt.....post mentum
prmt.....prementum
prs.....presternum
Psc.....prescutum
PTA.....posterior tentorial arm
s.....stipes
Sa.....subalare
SAL.....subanal lobe
SAP.....supre-anal lobe
Scl.....scutellum
Sct.....scutum
SGP.....subgenital plate
Sp.....spiracle
Ss.....spini-sternum
Stn.....sternum
T.....tergum
Tg.....tegula
Tn.....trochantin
Tr.....trochanter

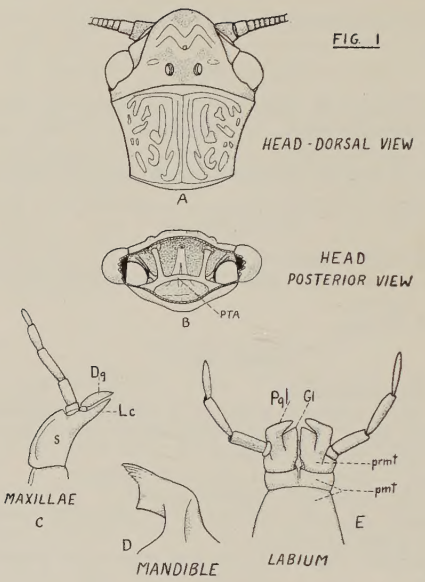
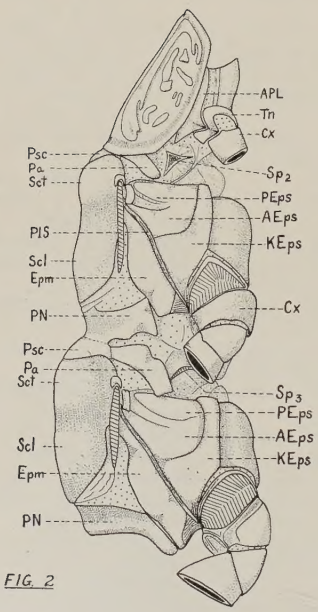


FIG. 1
HEAD - DORSAL VIEW
A
HEAD
POSTERIOR VIEW
B
PTA
Dq
Lc
S
MAXILLAE
C
Pql
Gl
prmt
pmt
E
D
MANDIBLE
LABIUM


APL
Tn
Cx
Psc
Pa
Scf
Sp2
PEps
AEps
PIS
KEps
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PN
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Sp3
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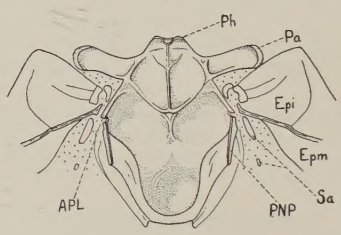
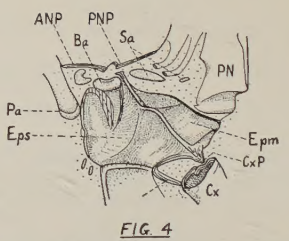
KEps
Epm
PN
FIG. 2


Ph
Pa
Epi
Epm
Sa
APL
PNP
FIG. 3


ANP
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Ba
Sa
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CxP
Cx
FIG. 4

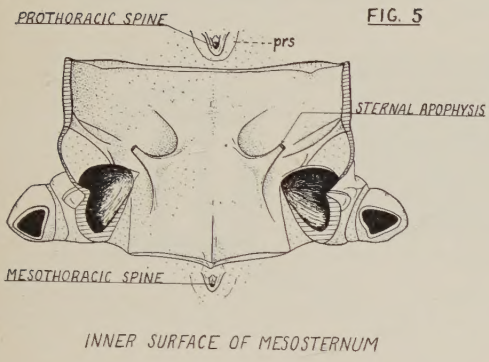

FIG. 5

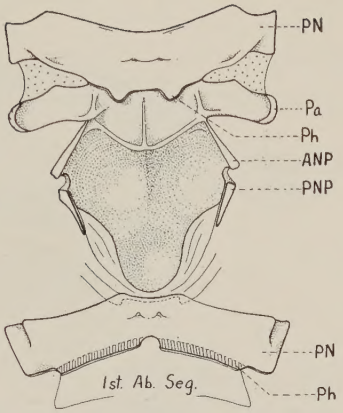

FIG 6

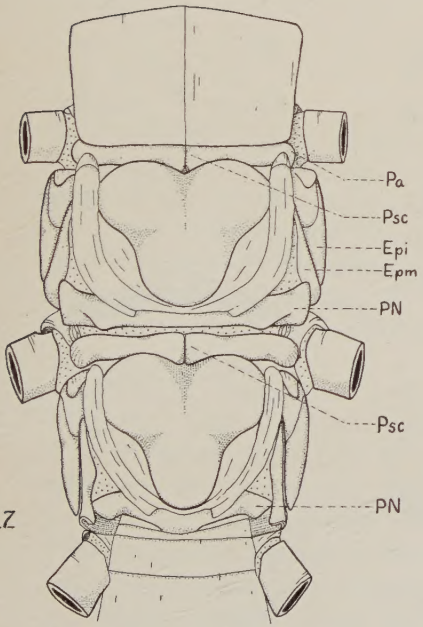

FIG. 7

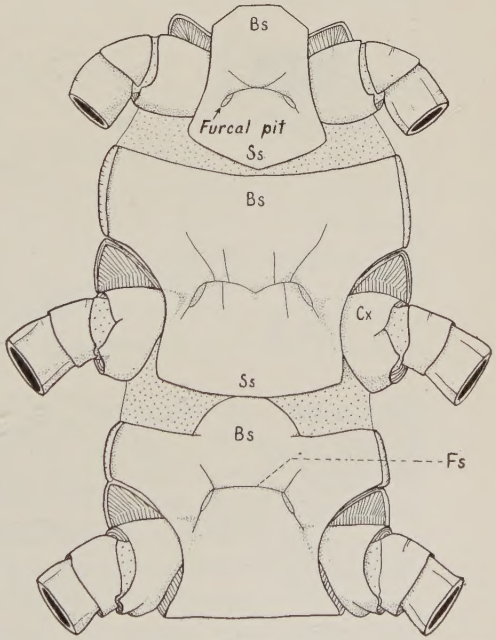

FIG. 8

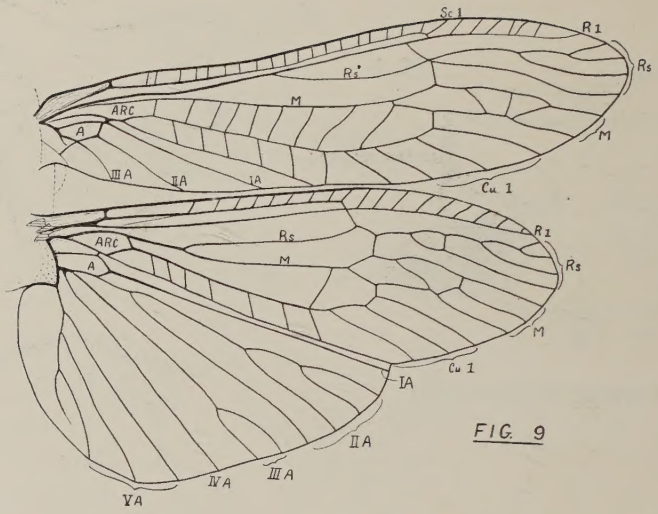

FIG. 9

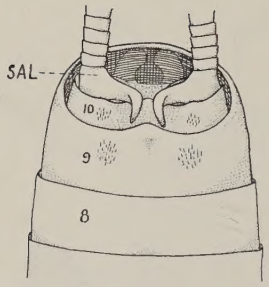

FIG. 10

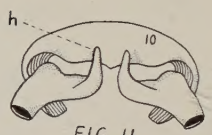

FIG. 11

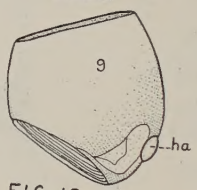

FIG. 12

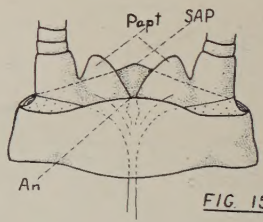

FIG. 15

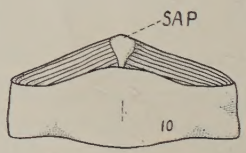

FIG 16

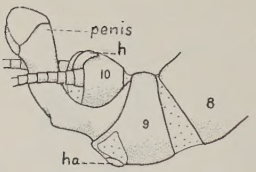

FIG 14

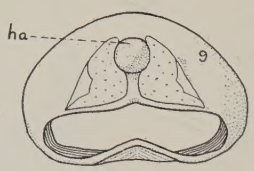

FIG. 13

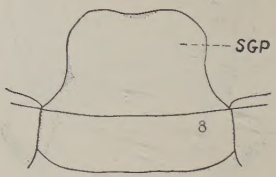

FIG. 17